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MEASUREMENTS OF BIRDS

By

S. Prentiss Baldwin, Harry C. Oberholser,

and

Leonard G. Worley

21

Illustrations by James Manson Valentine

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PUBLICATIONS
OF THE CLEVELAND MUSEUM OF NATURAL HISTORY

The publications of the Cleveland Museum of Natural History appear in six series, as follows:

1. *Scientific Publications*, consisting of natural history and anthropological papers of technical character, of varying length and appearing at irregular intervals.

   Of this series, all of Volume I, containing numbers 1–5, issued, 1928–1931, has already been published. The present contribution constitutes Volume II complete.

2. *Popular Publications*, which are non-technical articles of general natural history or anthropological interest, issued also at irregular intervals.

   Of this series, numbers 1–2 of Volume I have appeared, 1928–1931.

3. *Bulletin*, containing short popular, educational, or semi-technical articles on natural history and anthropology; notes on the Museum's activities; and the Museum's announcements. It is published monthly, except in July and August.

   Of this publication, numbers 1–51 have been issued, 1922–1931.

4. *Pocket Natural Histories*, consisting of popular pocket educational manuals for the information of students in natural history and anthropology, including keys and illustrations for the ready identification of species.

   Of this series the following have been published:

   No. 1—Trees of Ohio, 1922.
   No. 2—Indian Homes, 1925.
   No. 3—Mound Builders, 1925.

5. *Annual Report*, containing the report of the Director and the reports of the different departments of the Museum, setting forth their activities during the preceding year.

   Two of these have been published, those for 1929 and 1930.

6. *Miscellaneous Publications*, comprising educational leaflets; and such other publications of local or temporary interest as descriptions of the Museum and its work, post cards, cards for games, lecture and other programs, and announcements of other Museum activities.

   A considerable number (about 100) of such publications have already appeared.

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Birds

SCIENTIFIC PUBLICATIONS

OF THE

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MEASUREMENTS OF BIRDS

BY

S. PRENTISS BALDWIN, HARRY C. OBERHOLSER,
AND LEONARD G. WORLEY

ILLUSTRATIONS BY JAMES MANSON VALENTINE

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INTRODUCTION

The importance of statistical studies in biology does not need much emphasis. Attention may well be called, however, to the great variation—geographical, sexual, seasonal, age, and individual—in the size and proportions of birds, which differences can not be properly evaluated without good series of measurements.

Measurements of birds, and the relative proportions determinable only by measurements, are used (1) for purposes of generic and even family characterizations, to indicate the differences and similarities between such groups; (2) to show differences between species and between subspecies; and (3) to bring out the many kinds of variation within the limits of species and subspecies. Some measurements are suitable for all three of these purposes; others, by their nature, for only one.

A search of the literature of ornithology for some reasonably complete system of measurements discloses only a surprising meagerness of information on the subject. The reason for such scant reference to any method of measuring birds seems to have been, partly, that a few simple measurements which give an idea of size have, rather remarkably, been considered sufficient for the description and identification of species, and that for such taxonomic purposes no detailed system has usually been thought necessary; although in some families or genera of birds certain

special features have assumed so much importance that they have required comparison by measurement. Also, authors have apparently supposed that their methods of measurement needed no explanation. However, when the physiology, the life processes, and the close scrutiny of the individual bird as a living organism are considered, the careful comparison of minor variations becomes essential. For the study of individual variations, sexual differences, rate of growth, anatomy, and ecological relationships, a much more extensive series of measurements is required.

For use in the studies of living birds that are being carried on at the Baldwin Bird Research Laboratory at Gates Mills, near Cleveland, Ohio, it was found by Baldwin necessary to work out an adequate system of measurements. Originally such measurements were intended to include only those that pertain to the living bird, but even this involved much research into the methods employed by others. Oberholser suggested the addition of detailed explanations of the manner of taking all the principal external measurements that can be profitably employed in ornithology in any part of the world, both of birds in the flesh and of museum specimens as well, exclusive of the skeleton and other internal parts. No effort has been spared to work out as accurately as possible a satisfactory system of measurements, and in view of the lack of such a comprehensive manual, it has been thought worth while to publish the results of these studies. To make these more clearly understood, outline drawings showing the manner in which many of the more important measurements are taken have been added.

Our purpose in this connection, however, is not

revolutionary, but rather confirmatory of such methods as exist; and we endeavor in the following pages so to describe and illustrate a large number of measurements that may be found useful, as to lead to some recognized standard and consequent uniformity. Since it is evident that differences in method greatly reduce the comparative value of series of measurements, our modest hope is that the present effort may contribute to the uniformity so much to be desired, if only by showing how much more available for comparison measurements are if taken by a uniform method. The need for uniformity in this respect has, indeed, long been recognized. A hundred years ago William Swainson in a footnote on page 44 of the second volume of the immortal 'Fauna Boreali-Americana' voiced his own feeling in the following words:

"It is very desirable that authors should adopt one uniform mode of measurement, or at least explain their methods more accurately, until some definite plan is adopted."

There is, it is encouraging to note, evidence to-day of an increasing desire on the part of ornithologists for uniformity in the method of taking measurements.

The measurements that are useful for the majority of birds, or are most often necessary for general study, are, in the present publication, set in larger type. In order, however, to aid in promoting further agreement or standardization many measurements are described here which may be needed only for studies of certain genera, or for investigations requiring great detail. These are set in smaller type. . . .

While many of these will not often be used, and probably not all of them by any one investigator, yet

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they may serve for suggestion and help should they be needed. Many measurements could, of course, be added to those given in the following pages, but it seems best to leave further refinement to the exigency of any special investigation that may in future be undertaken. However, when measurements of many more kinds and in much greater detail than at present are employed in all kinds of ornithological studies, it is very probable that many hidden differences will be brought to light, and that many interesting, not to say important, ornithological discoveries will be made. We have, in fact, perhaps in part on account of the labor involved, made altogether too little use of measurements in ornithological research.

For ordinary taxonomic purposes in the laboratory or in the field, the few subjoined measurements are in most general use, usually in the same sequence as given below; and to follow this order, when only these measurements are furnished, will facilitate their use:

(1) Total length ('length').
(2) Extent of wings ('extent').
(3) Length of closed wing ('wing').
(4) Length of tail ('tail').
(5) Length of exposed culmen ('exposed culmen').
(6) Length of tarsus ('tarsus').
(7) Length of middle toe ('middle toe').

In scientific studies of any kind a measurement for each of these based on a single individual is not sufficient; the maximum, minimum, and average of a series of individuals should be given. Furthermore, all measurements should be taken in millimeters. In the

discussion of methods in the following pages we have departed from the sequence above given in order to bring into juxtaposition the most closely related measurements and to facilitate reference.

In the few cases in which two or more methods have been more or less commonly used for the same measurement, we have indicated our preference by prefixing an asterisk to the paragraph of description.

The most essential instruments in taking measurements of birds are a pair of plain dividers (those without a joint in either arm being preferable) and a ruler graduated to halves of a millimeter. For the larger dimensions this is sufficiently accurate, but for the smaller parts the measurements should be shown to tenths of a millimeter. For ordinary purposes a ruler 500 millimeters long (about 20 inches) will be sufficient, but for larger birds a longer one is desirable. A vertical piece, securely fastened to the left end of the ruler, makes easier and more accurate the measuring of wings that are too long for dividers, but is in the way when taking other measurements. A steel or cloth pocket tape line is often useful, particularly for large birds. For the bill and the other smaller parts a pair of sharp-pointed calipers graduated to tenths of a millimeter will be found useful; and a pair of large wooden calipers for large birds is also an improvement, particularly for convenience and time saving.

The annotated bibliography to be found at the end of the following discussion of measurements includes citations of all publications found to have explained manner or method of taking measurements. It is doubtless not complete, but probably comprises the great majority of essential references. It is, moreover,

interestingly sufficient to show that ornithological writers ordinarily have used only a very few measurements, and that these, in many instances, are not so described as to show the exact method followed in obtaining them. Furthermore, most of the explanatory comments on measurements have appeared in recent years.

We, therefore, can not too strongly urge that, in all publications in which measurements are used, *the exact method of taking each measurement be fully and clearly described or illustrated.*

We wish to express our appreciation of the patience with which Doctor Valentine has applied not only the skill of an artist, but the naturalist's knowledge of birds, to the illustrating of this paper. For valuable suggestions we need thank Dr. S. Charles Kendeigh, of the Baldwin Bird Research Laboratory; Dr. H. H. T. Jackson, of the Biological Survey; and for painstaking work on the bibliography, Miss Ruth Richards, of the Biological Survey, United States Department of Agriculture, at Washington, D. C.

MEASUREMENTS

TOTAL LENGTH

Total length with feathers.—*The total length of a bird with its feathers is measured from the tip of the bill to the tip of the tail, the bird thoroughly relaxed, lying flat on its back along a ruler, with the head bent dorsally so that the bill is approximately parallel with the ruler, and without stretching the neck beyond a natural position. (Figure 1.) A bird too large for any ruler available may be measured by marking off on table or floor the points reached by the tip of the bill and the end of the tail, and measuring the distance between these points.

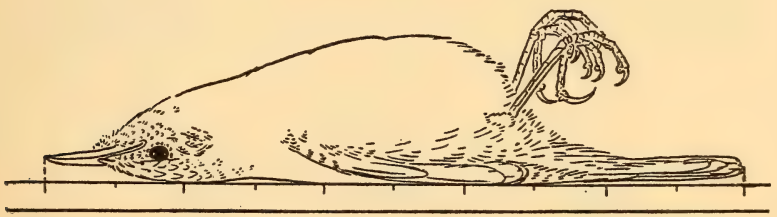

FIGURE 1.—TOTAL LENGTH WITH FEATHERS

The total length may be obtained from either the living or dead bird, but not accurately from a prepared skin, even though taken in exactly the same way. This measurement has been standard for many years. A slight source of error may be encountered in measuring a bird in the flesh, since there is some variation in

*When two or more methods of taking the same measurement are explained, the method preferred by the present authors is prefixed with an asterisk (*).

the stretching to which the neck may be subjected; but after a little practice this will not amount to more than one or two millimeters in the smaller birds, an inaccuracy that is, of course, not serious.[2]

By some authors the length is measured also to the tips of the shortest feathers of the tail, to show the difference between the lengths of the tail-feathers. This measurement is, of course, not the total length of the bird; and, furthermore, the difference between the long and short tail-feathers is much more graphically exhibited by measurements of the tail alone.

Total length without feathers.—The total length of a bird without its feathers is ascertained by measuring, with the bird in the same position, from the tip of the bill to the posterior end of the coccyx. (Figure 2.) Such a measurement is useful in comparing individual variations in the size of the body itself.

FIGURE 2.—TOTAL LENGTH WITHOUT FEATHERS

BILL

Measurements of the bill are best taken with dividers, and may be considered the same in the living bird as in the prepared skin, although in the latter the bill may be subject to a slight shrinkage in drying. Differences in the size of various parts of the bill,

[2]The most generally useful measurements are set in larger type.

particularly the length of the maxilla, the height of the bill at base, and the width, have been used in defining specific and even generic characters of birds since the first days of systematic ornithology. For all bill measurements *it is important to indicate clearly which of the following are used.*

Length of exposed culmen.—* The length of the bill may be measured in several ways. Many authors use the *exposed* culmen as the length of the bill, and measure it from the point where the *tips* of the feathers of the forehead impinge upon the culmen (that is, the point at which the feathers of the forehead in their natural position cease to hide the culmen), in a straight line to the tip of the culmen. This is, therefore, really the *chord* of the exposed culmen. (Figure 3.) This measurement is easy to take; more nearly approximates the visible length of the culmen as viewed from the side; and has besides the advantage that its posterior point of departure is the same as that at which it is convenient to measure the height and width of the bill.

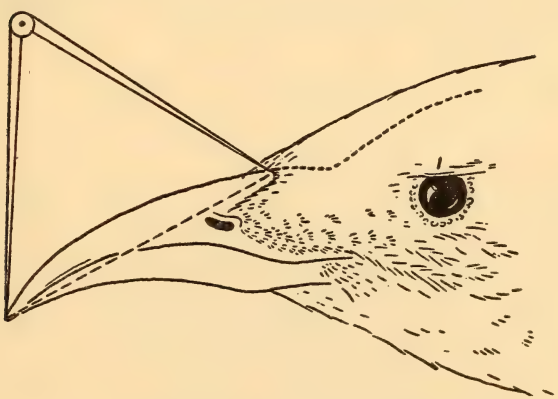

FIGURE 3.—LENGTH OF EXPOSED CULMEN

In birds that, like coots (*Fulica*) and jacanas (*Jacana*), have a frontal plate, the measurement of the exposed culmen begins at the anterior end of this bare portion of the forehead.

In the case of birds like crows and ravens (Corvidae), in which the base of the culmen may be more or less hidden by the thick tufts of nasal bristles, or frontal antiae, the point of departure for the measurement of the exposed culmen may be more or less obscure, but the point where the anterior feathers of the forehead cease to overlie the culmen can be ascertained by pushing aside the lateral tufts of bristles.

Length of exposed culmen without cere.—In birds having a noticeable cere, such as hawks (Accipitriformes), owls (Strigiformes), parrots (Psittaciformes) and pigeons (Columbiformes), the length of the culmen without cere is ascertained in the same manner as is the length of exposed culmen (see page 11), but by measuring from the anterior edge of the cere on the culmen to the tip of the bill. (Figure 4.)

FIGURE 4.—LENGTH OF EXPOSED CULMEN WITHOUT CERE

Length of total culmen.—Since there is sometimes considerable variation in the length of that part of the base of the bill covered by the frontal feathers, due to variation in the length of these feathers, or to accidental injury, the measurement of the total culmen is sometimes more accurate and comparable than the length of the exposed culmen. This length of the bill includes the entire culmen from the point where the integument of the forehead of the bird meets the horny covering of the bill, where the *roots* of the feathers usually begin (except in cered birds, for which see page 14), in a straight line to the tip of the bill (the chord of the total culmen). (Figure 5.) In birds with a cere, the posterior limit for this measurement should be the point where the feathers begin, or the anterior end of the frontal bones of the skull on the forehead (see page 14).

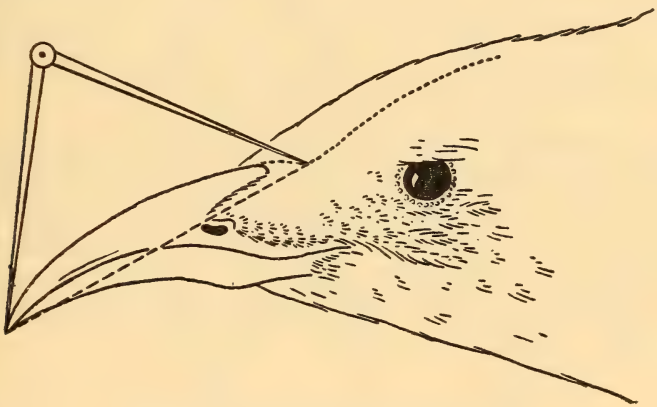

FIGURE 5.—LENGTH OF TOTAL CULMEN

In birds the frontal feathers of which do not overlie much or any of the base of the culmen, like the American orioles (*Icterus*) and Old World vultures (Aegypiidae), this measurement is nearly or quite the same as the length of the exposed culmen.

Some birds, like auks (Alcidae), have the base of the bill so extensively covered with feathers that it is necessary to begin the measurement of total culmen at the anterior end of the frontal bones of the skull on the forehead, even if this be among the feathers. This point, however, can usually be readily determined.

Although we prefer for ordinary taxonomic and other purposes the exposed culmen as the measurement of the whole bill, nevertheless, for all other measurements in which the culmen is involved (except height and width of bill at base) we use the extreme base of the culmen, as being the real posterior end of the maxilla, and as such offering a more logical and satisfactory point of departure.

The bill has by some authors been measured along the curve of the culmen instead of its chord, but this is a difficult measurement to obtain accurately, and is seldom if ever now employed.

Length of total culmen with cere.—In cered birds the length of the total culmen with cere is found in the manner described for birds without a cere (see page 13), except that in this case the base of the culmen is covered by the integument of the cere, and the measurement begins at the actual posterior end of the culmen as determined by the growth of feathers, or better by the configuration of the surface where the culmen ends at the anterior extremity of the frontal bones of the skull on the forehead.

Horizontal length of bill.—Some authors, such as Jonathan Dwight, have determined the length of the bill with a pair of calipers from the base of the exposed culmen, on a horizontal line to a point exactly above the anterior end of the bill, which would give neither the length of the culmen, nor the chord of the culmen, but, in fact, the greatest *horizontal* measurement that can be taken of the bill. (Figure 6.)

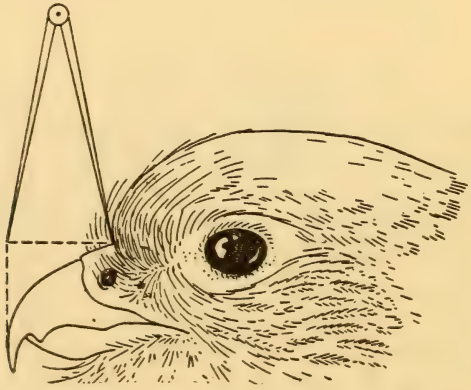

FIGURE 6.—HORIZONTAL LENGTH OF BILL

Such a measurement of horizontal length may be useful, however, in comparing sharply hooked bills of such birds as parrots (Psittaciformes) and hawks (Accipitriformes), but it is not a good substitute for the chord of the culmen, as there is considerable difference between these two measurements.

Length of bill from gape.—The length of the bill from the gape is the length in a straight line from the tip of the maxilla to the corner of the mouth; which measurement is, of course, the chord of the distance. (Figure 7.)

This measurement is often useful, supplementing other measurements of the bill; and it has been used by Martorelli (1895) and some other authors as the measurement of bill length.

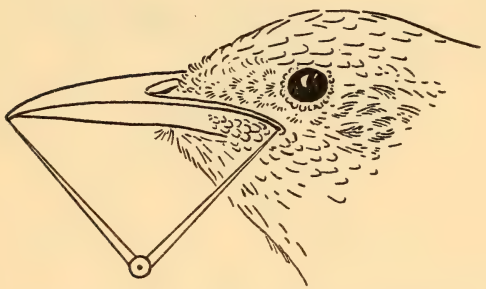

FIGURE 7.—LENGTH OF BILL FROM GAPE

Length of bill from nostril.—The length of the bill from the nostril is often a convenient measurement, particularly in large birds. It is taken with dividers from the middle of the anterior end of the nostril in a straight line to the anterior end of the maxilla. (Figure 8.)

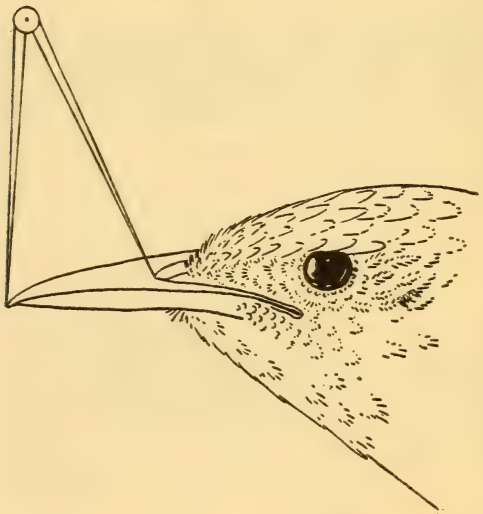

FIGURE 8.—LENGTH OF BILL FROM NOSTRIL

Length of bill to feathers on side of maxilla.—The distance from the tip of the bill (culmen) to the most anterior point of the feathering on the side of the maxilla is useful in birds like ducks (Anatidae), and should be measured in a straight line with dividers, as is the exposed culmen (see page 11). (Figure 9.)

This measurement is, of course, unobtainable in birds like Old World vultures (Aegypiidae) and cormorants (Phalacrocoracidae), which have no feathers on the maxilla.

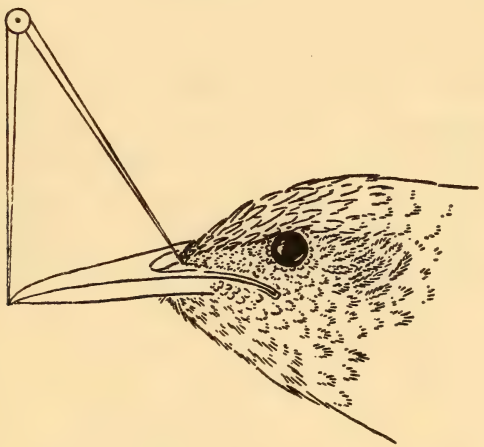

FIGURE 9.—LENGTH OF BILL TO FEATHERS ON SIDE OF MAXILLA

Length of bill to feathers on side of mandible.—The distance from the tip of the bill (culmen) to the most anterior point of the feathering on the side of the mandible should be measured in a straight line, as is the length of bill to the feathering on the side of the maxilla. This measurement is, of course, not germane in bald-faced birds. Compare this dimension with the length of exposed mandible (see page 38).

Height of bill at base.—* The height of the bill at the base is measured from the base of the exposed culmen (which is usually the highest point of the culmen) to the lower edge of the ramus of the mandible below, at the point that is antero-posteriorly opposite, which would almost always be the nearest point. (Figure 10.)

This is, of course, not a vertical measurement, but is the chord of the curved surface of the side of the bill. It is, however, so much more easily taken than the strictly vertical height, and therefore so much more likely to be accurate, that it is favored rather than the vertical height. It may be mentioned, moreover, that this measurement is the one used for height of bill by a great many, if not most, ornithologists, but it does not seem to be generally realized that this is not the vertical height of the bill. Attention has, however, recently been called to this matter by Major Allan Brooks.[3]

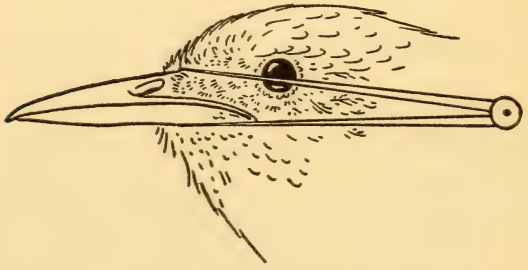

FIGURE 10.—HEIGHT OF BILL AT BASE

[3]The Auk, Vol. XXXVII, No. 3, July, 1920, p. 358.

The measurement of the **vertical height of the bill** can be taken, however, by placing one tip of the dividers at the base of the exposed culmen and the other tip directly below, under and at the middle of the mandible between the rami.

The difference between the measurement of the height of the bill here recommended (the chord of the lateral surface) and the vertical height is in small birds only a little, but in large species is so great as to amount to an entirely different measurement. It is, therefore, important always to state which of these measurements is used in any investigation.

In obtaining this measurement of the height of the bill care should be taken that the bill is tightly closed, otherwise the result will be more or less inaccurate. In general, the height of the bill at this point (the base of the exposed culmen) is a more satisfactory measurement than that at the extreme base of the culmen, because more easily and accurately obtainable on account of the often rounded character of the extreme basal end of the culmen.

Ridgway, in Volume I of his 'Birds of North and Middle America' (1901) used a measurement of the height of the bill taken from the base of the exposed culmen to the lower posterior (malar) angle of the bare portion of the side of the mandible; a measurement which is in some cases approximately the same as the above described measurement of the height of the bill at base (see page 18), but in many birds would be decidedly greater. It was used by Mr. Ridgway for only the Fringillidae, because of their conical bills. At least two or three subsequent authors have made use of the same measurement.

Height of bill at nostrils.—The height of the bill at the nostrils is measured in the same way as at the base (see page 18), from the culmen to the lower edge of the mandible (gonys or ramus, as the case may be), at the *anterior* end of the nostrils. (Figure 11.)

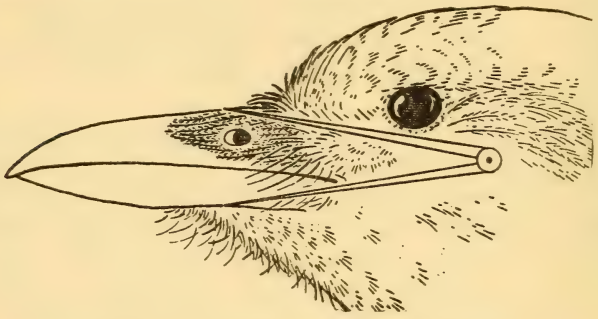

FIGURE 11.—HEIGHT OF BILL AT NOSTRILS

Height of bill at angle of gonys.—The height of the bill at the angle of the gonys is found in the same manner as at the base (see page 18), from the angle of the gonys to the ridge of the culmen directly above. (Figure 12.)

The last two measurements are useful in birds like crows (Corvidae) and gulls (Laridae), respectively.

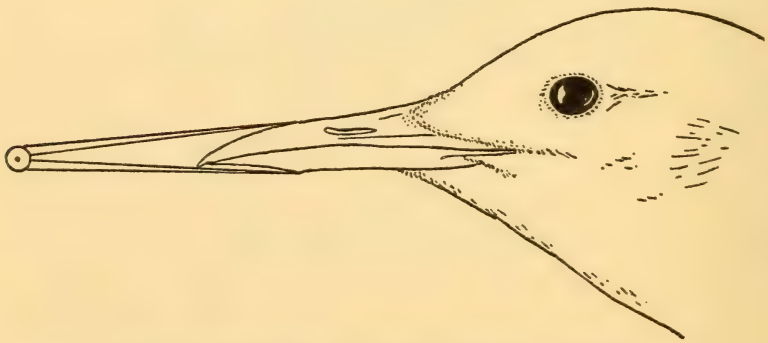

FIGURE 12—HEIGHT OF BILL AT ANGLE OF GONYS

Width of bill at base.—* Since the height of the bill at base is most satisfactorily measured at the base of the exposed culmen, the width of the bill at the base is more comparable if taken at the same point (see page 18). This measurement should therefore be taken directly below the base of the exposed culmen, and is the shortest distance from the cutting edge (commissure) on one side to the cutting edge on the opposite side. (Figure 13.)

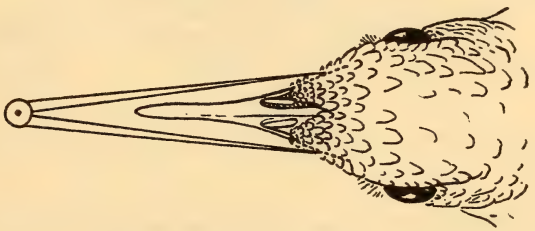

FIGURE 13.—WIDTH OF BILL AT BASE

Width of bill at gape.—The width of the bill at gape is measured with dividers from one corner of the mouth to the opposite corner, with the bill *closed*, since if the bill be open a less measurement will result. (Figure 14.)

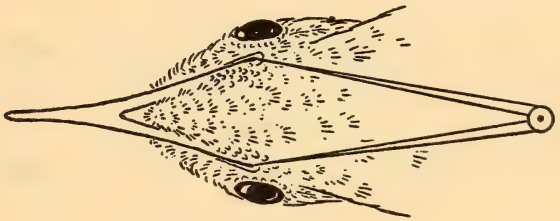

FIGURE 14.—WIDTH OF BILL AT GAPE

Width of bill at loral feathering.—This measurement has been used for birds like plovers (Charadriidae), but is not so comparably useful as are other measurements of the width of the bill. It is taken as is the width of the bill at base (see page 21), but at the point on the side of the bill where the loral feathering ends anteriorly.

Width of bill at posterior end of dertrum.—In birds such as ducks (Anatidae), which have a well-marked nail of the bill or other form of dertrum, the width of the bill at the posterior end of the dertrum (or nail) is sometimes useful. (Figure 15.) It is taken in the same way as the width of the bill at base (see page 21).

FIGURE 15.—WIDTH OF BILL AT POSTERIOR END OF DERTRUM

Width of bill at widest anterior point.—In birds such as spoonbills (Plataleidae) and certain ducks (Anatidae), the measurement of the width of the bill at the widest point anterior to the nostrils is useful (Figure 16), and is taken in the same manner as is the width of the bill at the base (see page 21).

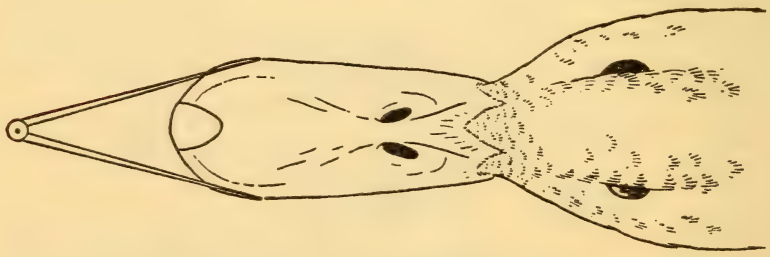

FIGURE 16.—WIDTH OF BILL AT WIDEST ANTERIOR POINT

Angulation of commissure.—The measurement showing how much the corner of the mouth is bent downward can be taken by means of a protractor to obtain this angle; and the position of the angle is found by measurement of the **length of the tomium** (Figure 17) and the **length of the rictus** (Figure 18). The degree and position of the angle vary in different species of birds.

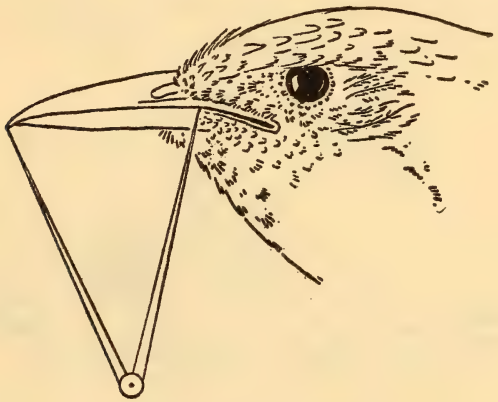

FIGURE 17.—LENGTH OF TOMIUM

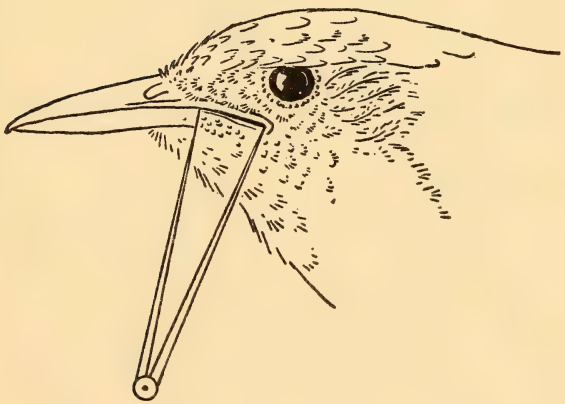

FIGURE 18.—LENGTH OF RICTUS

Extent of one mandible beyond the other.—Most birds have one of the halves of the bill, to a varying extent, longer than the other. Skimmers (*Rynchops*) have the maxilla shorter than the mandible; while in hawks (Accipitriformes), parrots (Psittaciformes), and many other birds the reverse is true. The distance that one mandible extends beyond the other should be measured in a straight line from the tip of the mandible to the tip of the maxilla, with the bill closed. In birds like parrots this measurement is, therefore, the chord of the distance. (Figure 19.)

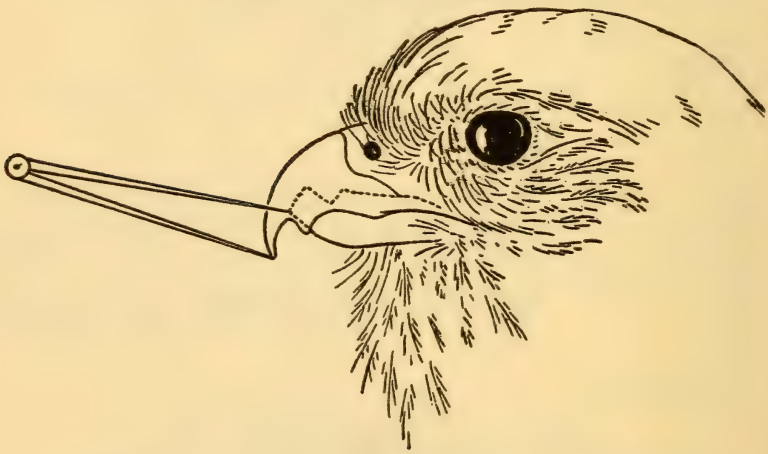

FIGURE 19.—EXTENT OF ONE MANDIBLE BEYOND THE OTHER

Curvature of culmen.—The curvature of the culmen is found in the same manner as the curvature of the wing (for explanation see page 83), by measuring the chord of the total culmen and the sagitta, then finding the ratio. (Figure 20.) Note should be made as to whether the bill is decurved or recurved.

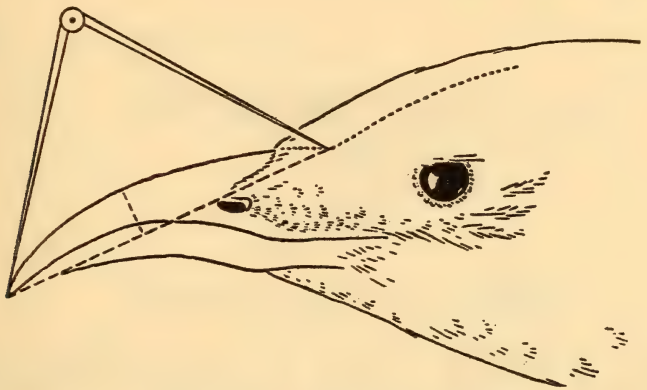

FIGURE 20.—CURVATURE OF CULMEN

Height of maxilla at base.—This is best taken at the same point as recommended for the measurement of the height of the bill (see page 18), that is, at the base of the exposed culmen. It is most satisfactorily measured from the frontal angle of the culmen to the point on the maxillar tomium directly below, which would be usually the nearest point on the cutting edge of the maxilla.

This is, as in the case of the height of the bill, of course, not a vertical measurement, being, in fact, the chord of the laterally curved surface of the maxilla. The strictly **vertical height of the maxilla** could be taken only by opening the bill and inserting one point of the dividers as far as the longitudinal center of the maxilla (palate), while the other point rests on the base of the exposed culmen; or by placing one point of the dividers on the cutting edge of the maxilla and holding the other point vertically above and laterally opposite the base of the exposed culmen. The difference between the chord of the side of the maxilla and the strictly vertical dimension is, as in the case of the height of the bill, so little in small birds as to be immaterial, but in birds like some very flat-billed ducks it is very great.

Greatest height of maxilla.—The altitude of the maxilla is the chord of its lateral surface, not the vertical measurement, but taken where this measurement will be greatest, from the culmen to the cutting edge of the maxilla. (Figure 21.) This point will, of course, vary much in different birds; and in many it will be the same as the height at base.

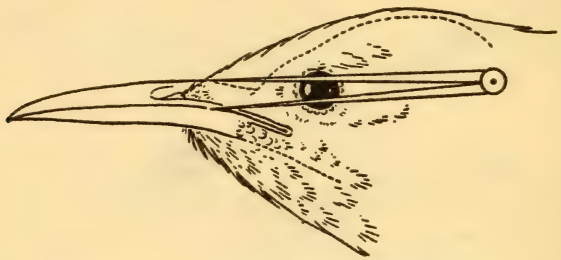

FIGURE 21.—GREATEST HEIGHT OF MAXILLA

Length of dertrum.—In birds like plovers (Charadriidae), which have the terminal portion of the maxilla developed into a well-defined turgid tip, or dertrum, it is often desirable to measure this part of the bill. The length of the dertrum is obtained with dividers from the point where its posterior end joins the culmen, in a straight line to its tip; this measurement being thus the chord of the dertrum. (Figure 22.)

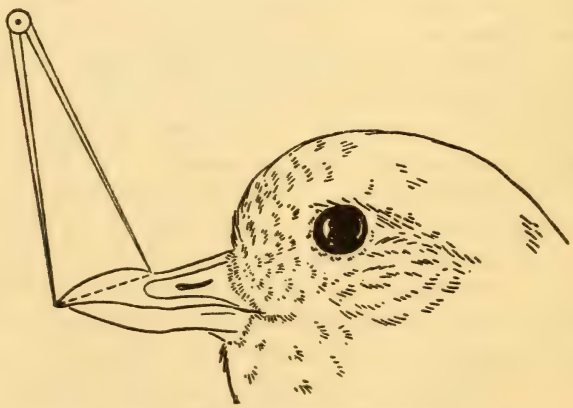

FIGURE 22.—LENGTH OF DERTRUM

Length of nail of bill.—In birds such as ducks (Anatidae), which possess a dertrum modified into a well-defined nail readily distinguishable on the upper side of the terminal portion of the culmen, it is sometimes desirable to ascertain the length of this nail. Such a measurement is taken with dividers from its posterior end to the tip in a straight line, and is of course the chord. (Figure 23.)

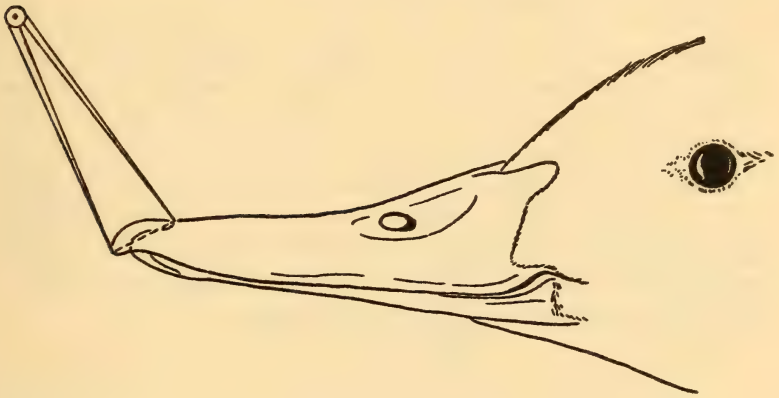

FIGURE 23.—LENGTH OF NAIL OF BILL

Greatest width of nail of bill.—This dimension is to be measured with dividers at the widest part of that portion of the nail that is visible from above, at right angles to the longitudinal axis of the nail. (Figure 24.)

FIGURE 24.—GREATEST WIDTH OF NAIL OF BILL

Width of nail of bill at its posterior end.—This measurement is sometimes used, and is taken in the same manner as the greatest width (see page 27). If the nail is of triangular shape, with the point at the posterior end, or if the nail tapers irregularly to a point, this measurement is of little value. If the nail narrows abruptly at the posterior end, this measurement is best taken at the point where this constriction begins.

Length of cere.—Whenever a cere is present on the maxilla the length of the cere on the culmen may be measured from the farthest anterior point of the cere on the culmen to the *insertion* of the feathers at its posterior edge on the culmen (Figure 25), or if the base lacks feathers, to the base of the forehead; and its length on the side of the maxilla from the farthest anterior portion of its edge on the side of the maxilla, in a straight horizontal line to the insertion of the feathers at its posterior edge. The latter measurement is not satisfactory in bald-headed birds.

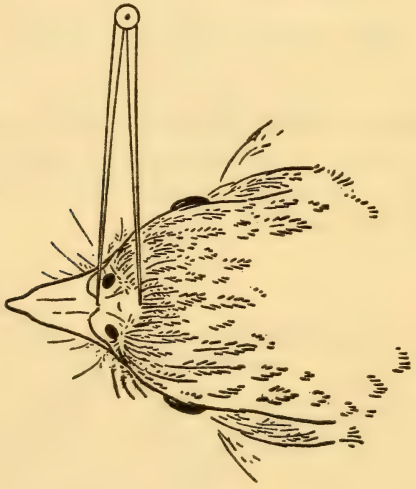

FIGURE 25.—LENGTH OF CERE

Height of casque.—The height, greatest width, and length of the casque on the bill of such birds as hornbills (Bucerotidae) are the most satisfactory measurements.

The height is taken with dividers in the same manner as the height of bill (see page 18), from the line of juncture with the culmen to the highest point of the central portion. (Figure 26.)

This is, of course, not a vertical measurement, but, as in the case of the height of bill, is much more easily taken accurately than is the strictly vertical height.

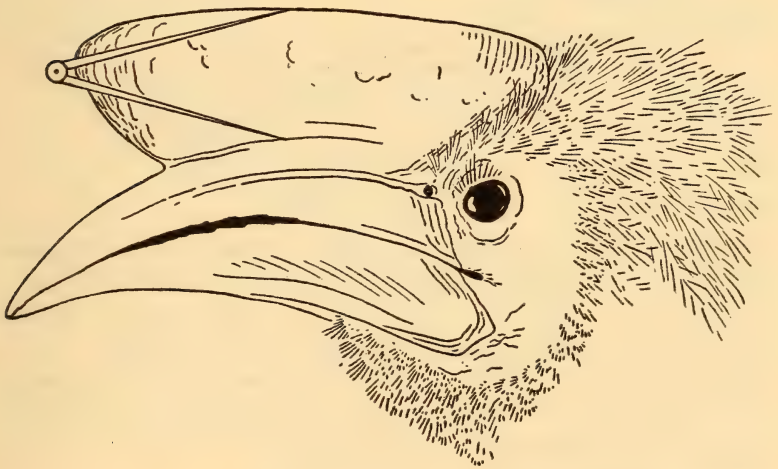

FIGURE 26.—HEIGHT OF CASQUE

Width of casque.—The width of the casque is measured at the widest point of the top (Figure 27); but if the top of the casque be so much rounded that the width can not be satisfactorily determined at that place, this measurement should be taken at the widest point between the top and the base, and a statement made to this effect.

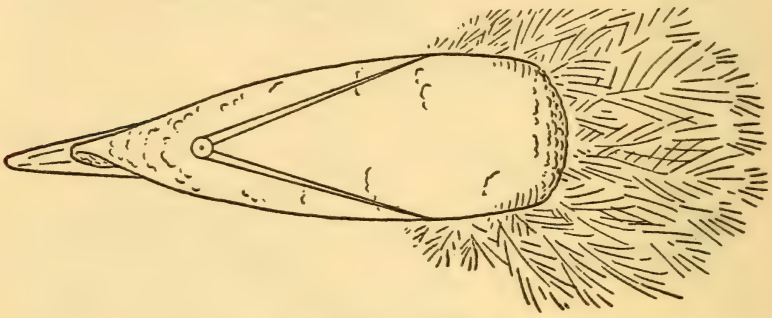

FIGURE 27.—WIDTH OF CASQUE AT TOP

If the width be measured also at the widest point of the base at the line of juncture of the casque with the culmen (Figure 28), it will give a better idea of the shape of the casque. In the figure the indicated position of the dividers is from below, better to illustrate the points from which the measurement is to be taken, but it is sometimes necessary, owing to the size of the mandible, to turn the dividers diagonally forward, or to place them from directly in front, astraddle the base of the casque.

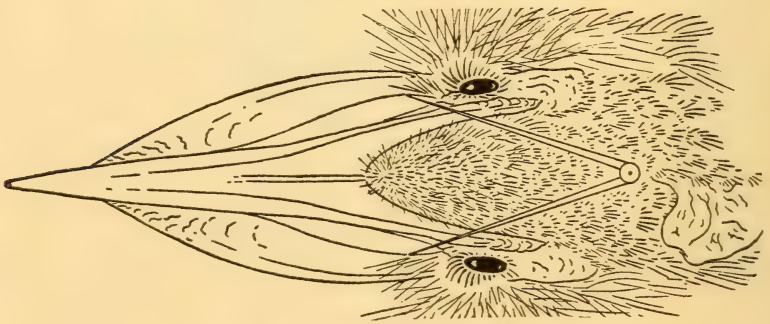

FIGURE 28.—WIDTH OF CASQUE AT BASE

Length of casque.—The length of the casque should likewise be measured at the top (Figure 29), and at the base (Figure 30); and, if neither of these points represents the greatest length, also at such point of greatest length.

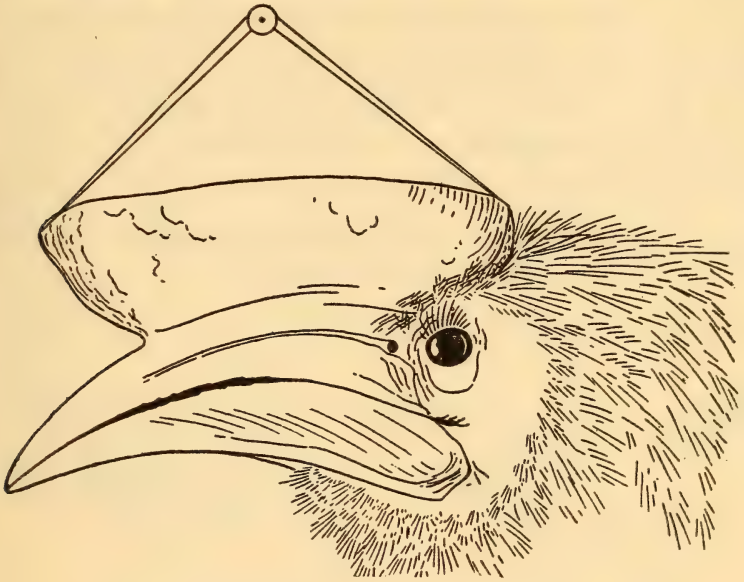

FIGURE 29.—LENGTH OF CASQUE AT TOP

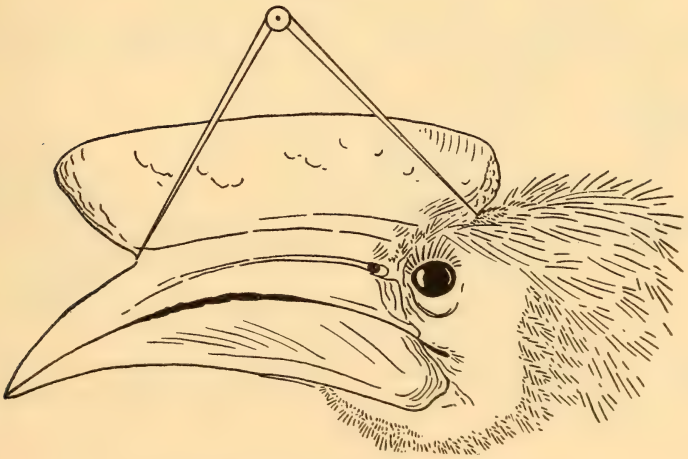

FIGURE 30.—LENGTH OF CASQUE AT BASE

Position of nasal fossa in maxilla.—The position of the nasal fossa is usually of most interest in birds with a rather high maxilla, such as gallinules, some rails (Rallidae), hawks (Accipitriformes), sparrows (Fringillidae), and similar forms. It is determined by four measurements, with dividers: the distance from its *anterior* end, in a straight line, (1) to the tip of the bill (Figure 31); (2) to the extreme base of the culmen (Figure 32); (3) to the nearest point, directly above, on the culmen (Figure 33); and (4) to the nearest point directly below on the cutting edge of the maxilla (Figure 34); the latter two measurements taken as is the height of bill at base (see page 18). In case the anterior end of the nasal fossa is rounded, the starting point for measurement should be at the middle of the anterior end of the fossa.

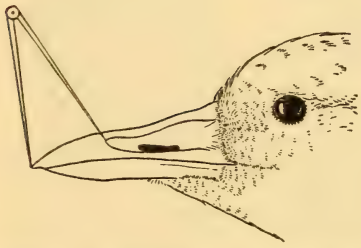

FIGURE 31.—POSITION OF NASAL FOSSA IN MAXILLA, FROM TIP OF BILL

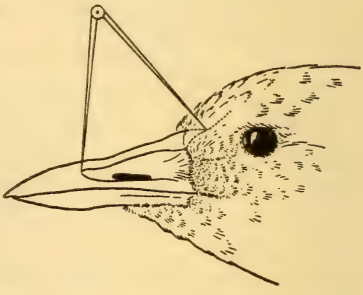

FIGURE 32.—POSITION OF NASAL FOSSA, FROM BASE OF CULMEN

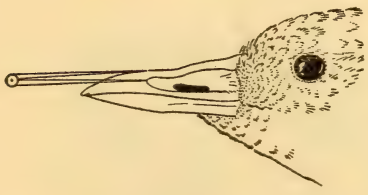

FIGURE 33.—POSITION OF NASAL FOSSA, FROM CULMEN ABOVE

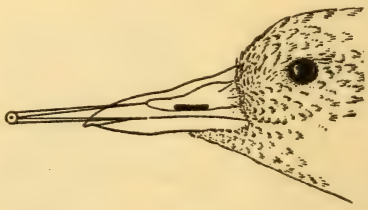

FIGURE 34.—POSITION OF NASAL FOSSA, FROM TOMIUM OF MAXILLA

Length of nasal fossa.—The length of the nasal fossa is measured with dividers, approximately parallel to the longitudinal axis of the fossa, but so as to obtain the greatest length, whether at the middle or some other part of the fossa. (Figure 35.)

In such birds as the mallard (*Anas platyrhyncha*) and other ducks (Anatidae), the nasal fossa is entirely surrounded by the unfeathered portion of the maxilla, and the length is easily ascertainable, as indicated in the preceding paragraph.

Many birds, however, such as the rails (Rallidae) and most passerine birds (Passeriformes), have the posterior portion of the fossa more or less feathered; and in such species the true length of the fossa is difficult or impossible to determine accurately, so that the most practical longitudinal measurement is thus from the anterior end of the fossa to the nearest point of feathering on the posterior portion of the fossa. (See Figure 38 for this posterior point.)

Some birds, as, for example, the true shrikes (*Lanius*) and the hawks (Accipitriidae) have no true nasal fossae, but have the maxilla more or less directly pierced by the nostrils.

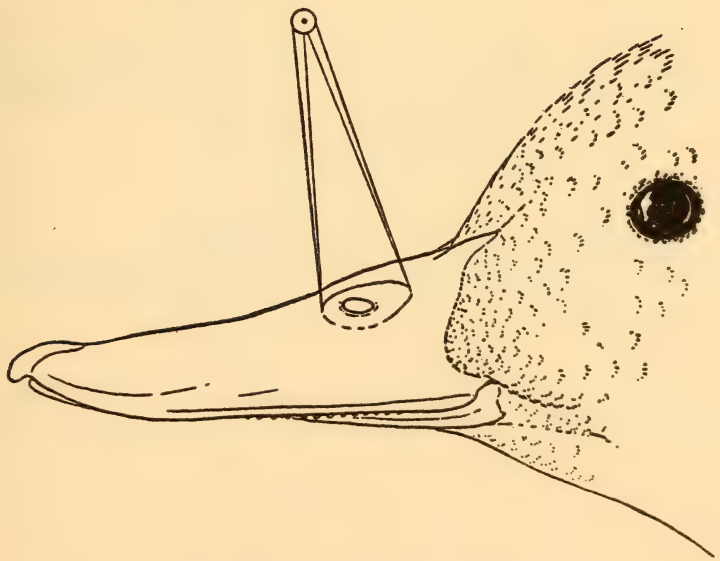

FIGURE 35.—LENGTH OF NASAL FOSSA

Height of nasal fossa.—The height (width) of the nasal fossa is determined by measurement at its highest (widest) point, wherever this may be. (Figure 36.)

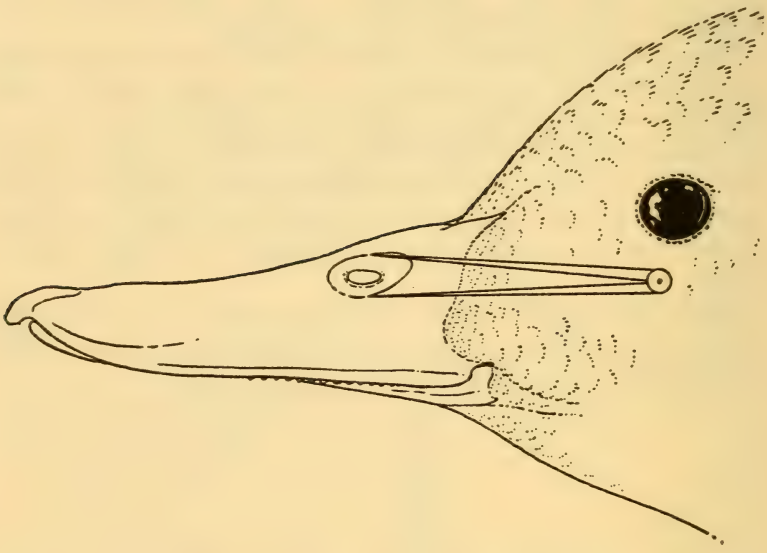

FIGURE 36. HEIGHT OF NASAL FOSSA

Position of nostril in fossa.—Four measurements will serve to locate the anterior end of the external opening of the nostril in the nasal fossa: the distance in a straight line from the anterior margin of the nostril (1) to the anterior end of the fossa (Figure 37); (2) to the hindmost point of the posterior end of the fossa or to the nearest point of feathering on its base (Figure 38); (3) to the upper margin of the fossa directly above (Figure 39); and (4) to the lower margin of the fossa directly below (Figure 40); measured not vertically, but as is the height of the bill at base (see page 18).

Detailed studies of the nostril and fossa will probably require the same measurements from their posterior edges.

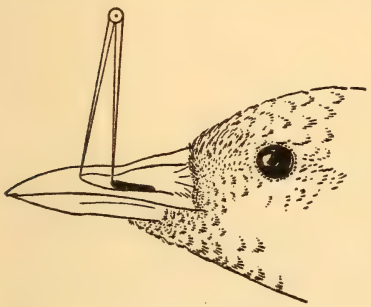

FIGURE 37.—POSITION OF NOSTRIL, FROM ANTERIOR MARGIN OF FOSSA

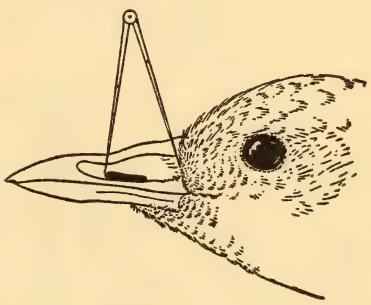

FIGURE 38.—POSITION OF NOSTRIL, FROM POSTERIOR MARGIN OF FOSSA

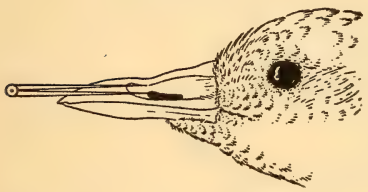

FIGURE 39.—POSITION OF NOSTRIL, FROM UPPER MARGIN OF FOSSA

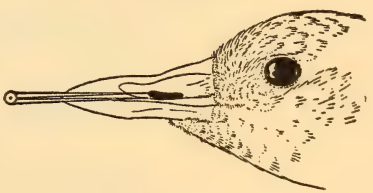

FIGURE 40.—POSITION OF NOSTRIL, FROM LOWER MARGIN OF FOSSA

Position of nostril in maxilla.— *The position in the maxilla of the nostril opening can be located with dividers by measuring from the same points in exactly the same way as the position of the nasal fossa is determined (see page 32), using the *anterior* edge of the nostril as the starting point.

This position is sometimes determined from the *posterior* instead of the anterior border of the nostril, but it is better to use the same point as is used for the position of the nasal fossa, since the measurements are thus more comparable.

Length of nostril.—The length of the external opening of the nostril is obtained by measurement of its greatest approximately horizontal length. (Figure 41.)

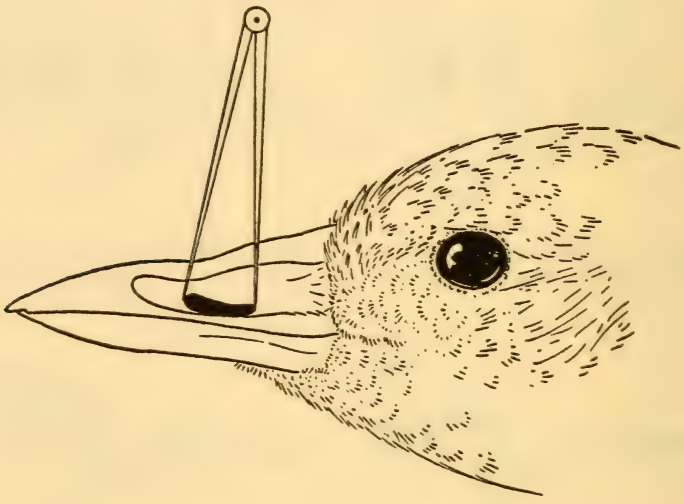

FIGURE 41.—LENGTH OF NOSTRIL

Height of nostril.—The height (width) of the nostril is measured at its widest point. (Figure 42.)

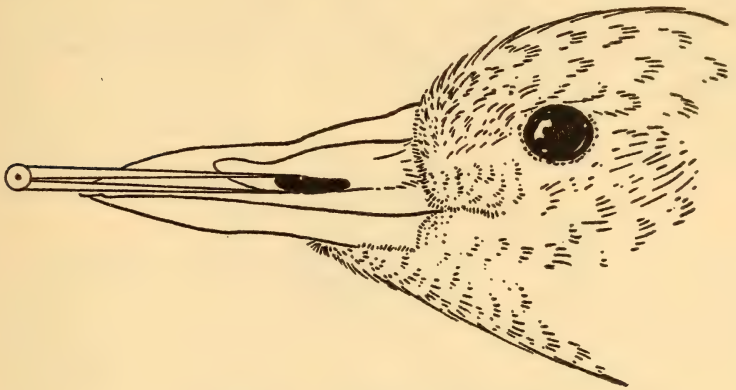

FIGURE 42.—HEIGHT OF NOSTRIL

Total length of mandible.—Measurements of the length of bill described in literature are invariably measurements of the maxilla, while dimensions of the mandible, as a whole, which is rarely of similar size, have not been taken. The total length of the mandible (the length of the mandible to the gape), may be found by measuring in a straight line the distance (chord) from its tip to the corner of the mouth. (Figure 43.)

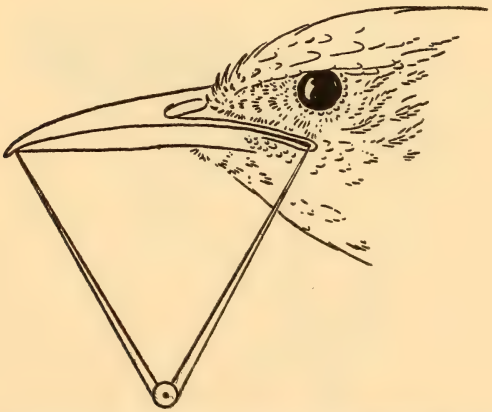

FIGURE 43.—TOTAL LENGTH OF MANDIBLE

Length of exposed mandible.—The length of the exposed portion of the mandible may be measured in a straight line from the tip of the mandible to the anterior point of the covering of feathers or skin on its lateral surface. (Figure 44.)

In some birds this measurement is the same as that of the total length of mandible (see page 37.)

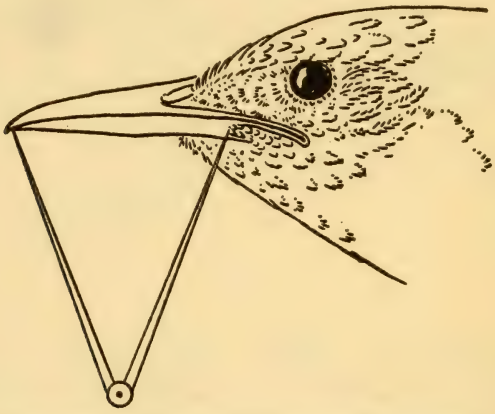

FIGURE 44.—LENGTH OF EXPOSED MANDIBLE

Length of mandible to feathering on chin.—This measurement should be taken with dividers in a straight line from the tip of the mandible to the anterior point of the feathering on the chin. (Figure 45.)

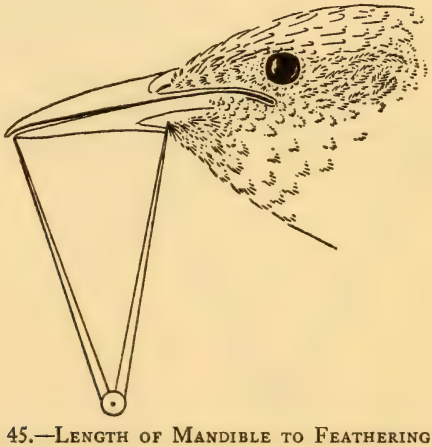

FIGURE 45.—LENGTH OF MANDIBLE TO FEATHERING ON CHIN

Height of mandible at base.—This should, for purposes of best comparison, be taken at the same point as the height of the bill (see page 18), at a point below and laterally opposite the base of the exposed culmen. It is the distance from the cutting edge of the mandible at this point to the corresponding place below on the lower edge of the ramus of the mandible. As in the case of the height of the bill at base (see page 18) this is not strictly a vertical measurement, but it is the chord of the lateral surface of the mandible.

Greatest height of mandible.—The altitude of the mandible is ascertained by measuring with dividers the greatest dorso-ventral diameter of the mandible, at whatever point this happens to be. This should be taken with the bill agape to expose all of the mandible. (Figure 46.) It is not a strictly vertical measurement, but is taken with dividers in a straight line from the cutting edge of the mandible to the lower edge of the ramus or gonys, directly below.

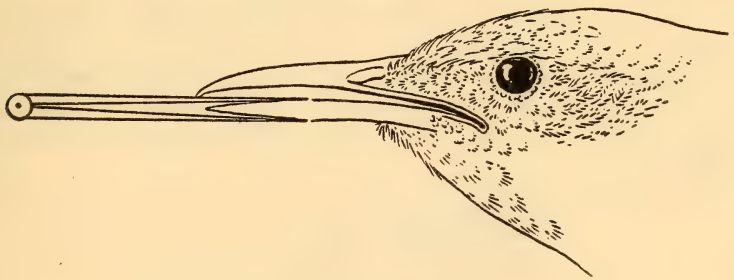

FIGURE 46.—GREATEST HEIGHT OF MANDIBLE

Width of mandible at base.—The width of the mandible at the base is a useful measurement, particularly in the finch family (Fringillidae) and in weaver-birds (Ploceidae). It is taken at the base of the exposed (unfeathered) portion of the mandible, from the outside of the extreme posterior end of one ramus to the same point on the other. (Figure 47.)

By a few authors this measurement has been used as the width of the bill, but while this part of the bill is usually wider than the corresponding portion of the maxilla, it is less than the width at gape. When employed, it should be fully explained.

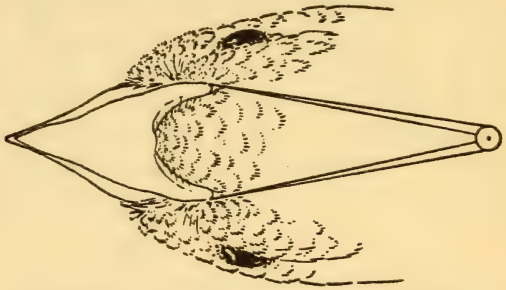

FIGURE 47.—WIDTH OF MANDIBLE AT BASE

Length of exposed ramus.—The length of the bare portion of the ramus is measured in a straight line from the posterior end of the gonys to the edge of the feathers on the base of the ramus. (Figure 48.)

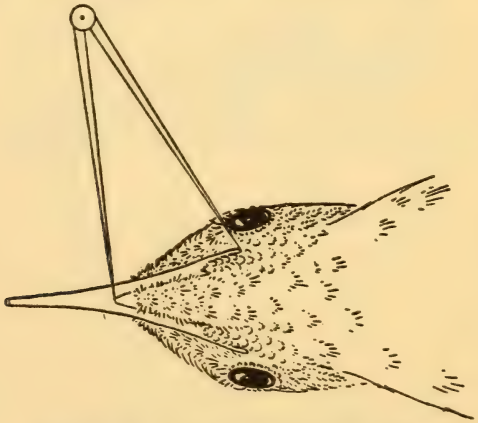

FIGURE 48.—LENGTH OF EXPOSED RAMUS

Length of gonys.—The length of the gonys is measured in a straight line from the tip of the mandible to the point where the rami join to form the gonys. (Figure 49.)

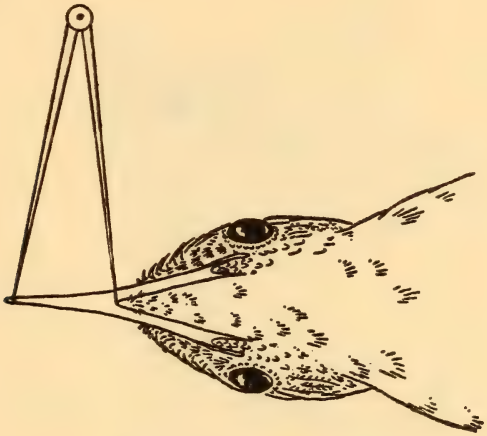

FIGURE 49.—LENGTH OF GONYS

Distance from angle of gonys to feathers on side of mandible.—This measurement is to be taken from the gonydeal angle, in a straight line to the anterior point of the feathering on the side of the mandible. (Figure 50.)

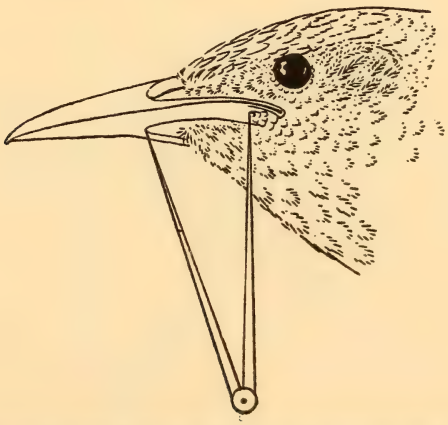

FIGURE 50.—DISTANCE FROM ANGLE OF GONYS TO FEATHERS ON SIDE OF MANDIBLE

Distance from angle of gonys to gape.—The distance from the angle of the gonys to the gape should be measured in a straight line from the junction of the rami to the gape (corner of the mouth). (Figure 51.)

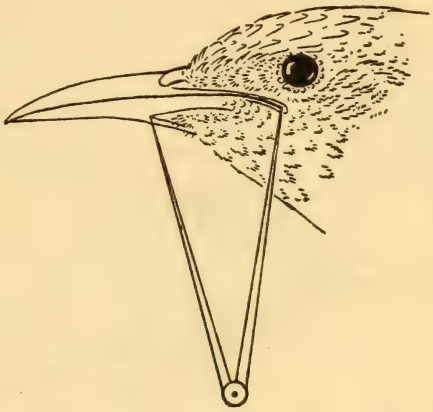

FIGURE 51.—DISTANCE FROM ANGLE OF GONYS TO GAPE

Distance from angle of gonys to feathering on chin.—This is measured in the same way as is the distance from the tip of the mandible to the chin feathers (see page 38), but from the posterior end of the gonys to the anterior point of the feathering on the chin.

Length of rictal bristles.—To obtain the length of these, the longest bristle should be straightened and measured to its tip from its insertion at the base. (Figure 52.)

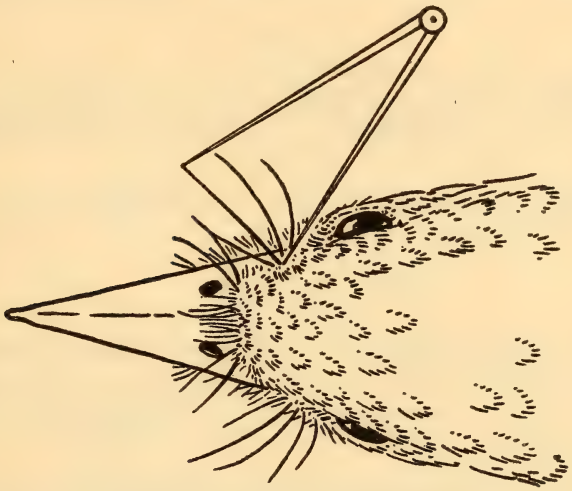

FIGURE 52.—LENGTH OF RICTAL BRISTLES

Length of tongue.—The length of the tongue is measured in a straight line with dividers from the posterior extension of the fleshy portion, to the tip, while the tongue is held straight. (Figure 53.)

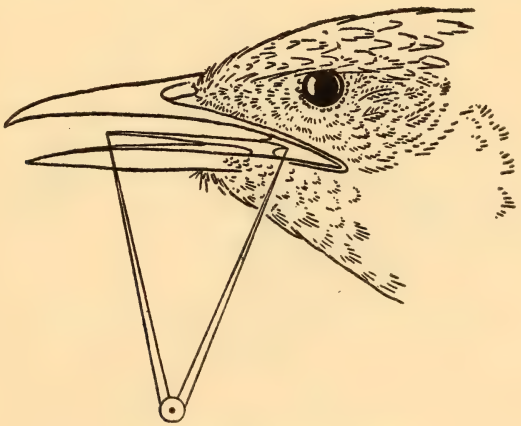

FIGURE 53.—LENGTH OF TONGUE

Width of tongue.—The width of the tongue is measured at its widest point with dividers from one edge of the fleshy portion to the other. (Figure 54.)

FIGURE 54.—WIDTH OF TONGUE

HEAD

Some of the following measurements of the head and its parts may be taken from the bird either in the flesh or from a prepared skin, but several of them only, or most satisfactorily, from the former; and most easily and accurately with dividers.

Length of head.—The length of the head is measured in a straight line from the extreme base of the culmen to the hindmost point of the head, on the occiput. (Figure 55.)

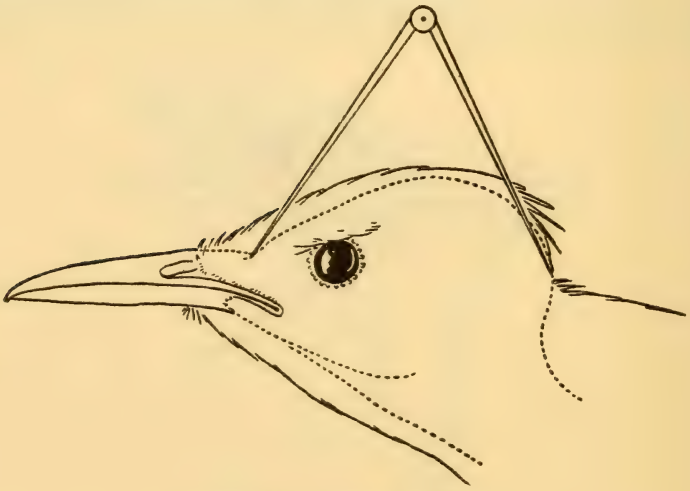

FIGURE 55.—LENGTH OF HEAD

Greatest width of head.—This should be taken at the widest part, just posterior to the eyes, with the tips of the dividers placed at exactly corresponding points on opposite sides of the head. (Figure 56.)

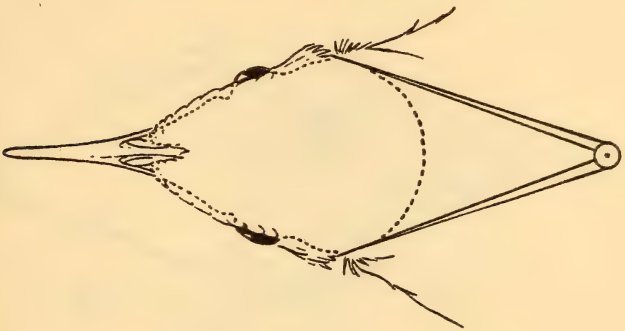

FIGURE 56.—GREATEST WIDTH OF HEAD

Interorbital width of head.—This is taken between the eyes in the same manner as the greatest width of the head, and is the shortest space between the eyes in the bird in the flesh, measured from the middle of the upper lid of one eye to the same part of the upper lid of the other. (Figure 57.) This dimension can be ascertained almost as satisfactorily from a well-made museum specimen.

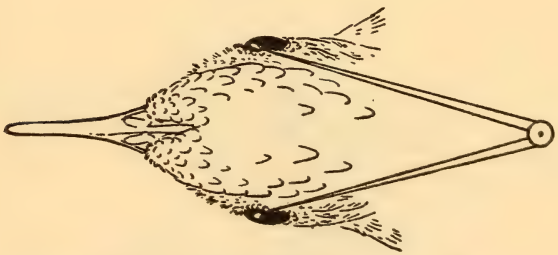

FIGURE 57.—INTERORBITAL WIDTH OF HEAD

Height of head.—The height of the head is the greatest dorso-ventral measurement that can be taken vertically. To obtain this, one point of the dividers is pressed in against the middle of the throat of the bird, and the other point is brought down against the top of the head at a point exactly above. (Figure 58.)

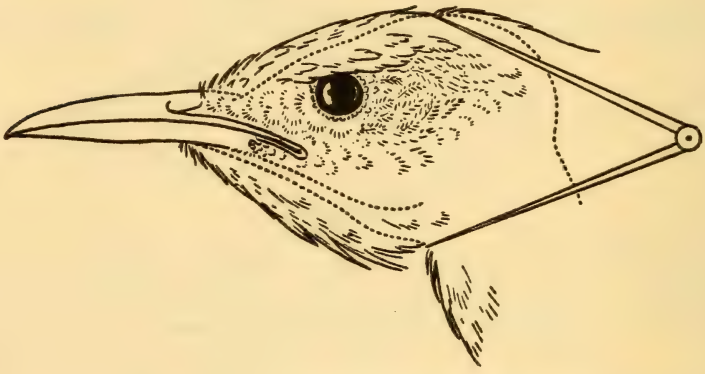

FIGURE 58.—HEIGHT OF HEAD

Height of eye.—The height (greatest vertical diameter) of the eye (Figure 59) is measured in a straight line between the lids of the open eye, in the bird in the flesh.

Eye diameters can not, of course, be taken from the preserved skin.

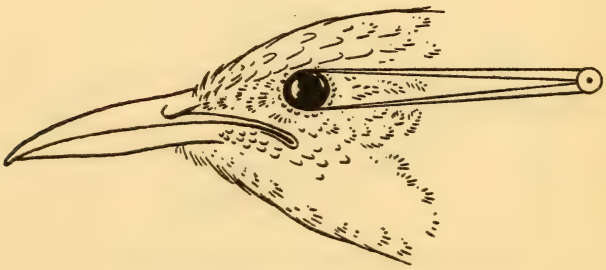

FIGURE 59.—HEIGHT OF EYE

Length of eye.—The length of the eye is taken with dividers, in a straight line from the hindmost point to the anterior end; between the lids of the open eye, as is the height (see page 46). (Figure 60.)

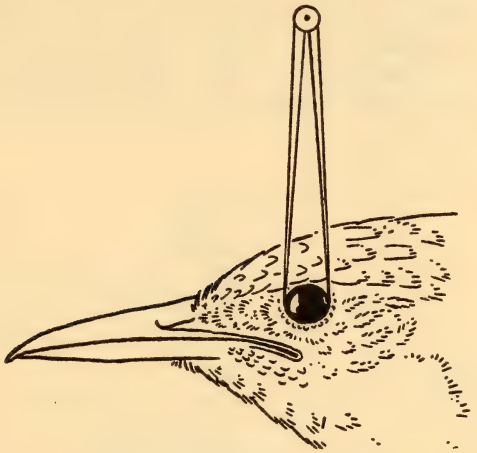

FIGURE 60.—LENGTH OF EYE

Distance from eye to nostril.—The distance from the anterior corner (when the eye is round, the nearest point) of the eye to the posterior border of the nostril is used as a specific character in some swans, and may prove useful in other birds. (Figure 61.)

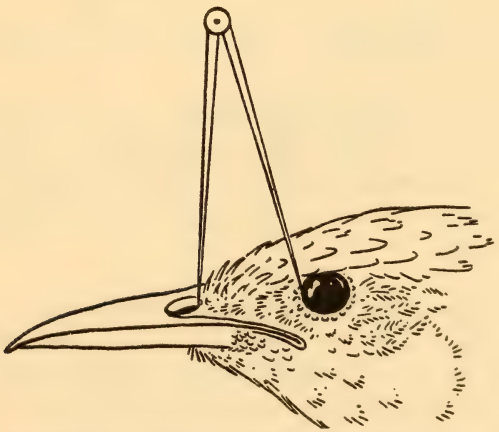

FIGURE 61.—DISTANCE FROM EYE TO NOSTRIL

Distance from eye to base of bill.—A measurement to show the distance from the eye to the bill is taken from the anterior corner (when the eye is round, the nearest point) of the eye to the culmen at the anterior insertion point of feathers (i. e., the extreme base of the culmen) (Figure 62); or, in birds which lack feathering at the base of the bill, to the anterior extension of the skin of the head; except in cered birds, in which the measurement should be taken to the actual base of the culmen, disregarding the cere.

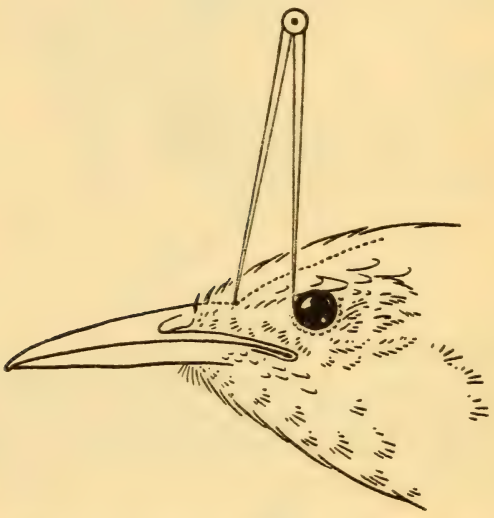

FIGURE 62.—DISTANCE FROM EYE TO BASE OF BILL

Distance from eye to tip of bill.—The distance from the eye to the tip of the bill is measured as is the chord of the exposed culmen (page 11) with dividers in a straight line from the anterior corner (when the eye is round, the nearest point) of the eye to the tip of the maxilla.

Distance from loral feathering to nostril.—In certain birds the distance from the loral feathers to the nostril is a useful measurement. It is taken with dividers from the point where the loral feathers extend farthest anteriorly on the side of the maxilla, in a straight line to the *posterior* end of the nostril.

Diameter of outer ear.—The greatest diameter of the outer ear (Figure 63) and its least diameter (Figure 64) will show the variation in its size among birds. Owls (Strigiformes), for example, have the outer ear relatively large. Both these measurements should be taken from the edges of the depression that forms the outer ear; or if these are not discernible, from the edges of the ear opening itself, and a statement made to that effect.

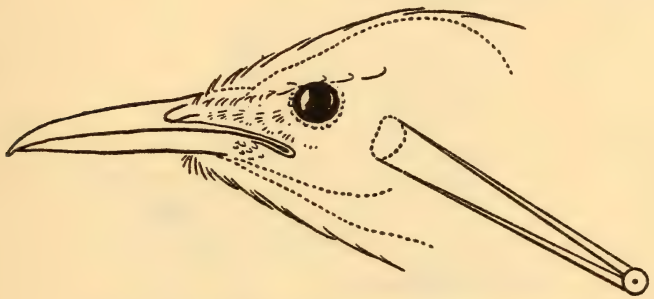

FIGURE 63.—GREATEST DIAMETER OF OUTER EAR

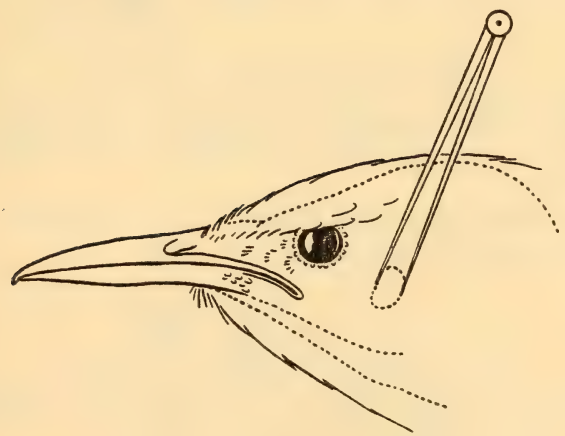

FIGURE 64.—LEAST DIAMETER OF OUTER EAR

Length of frontal plate.—The greatest length of frontal plates such as are found on coots (*Fulica*), gallinules (*Gallinula, Porphyriola*), and jacanas (*Jacana*) is measured in a straight line with dividers. Since the frontal plate is often more or less triangular, or the ends irregular, one extremity may not be exactly in front or behind the other end, in which case the measurement of length should be taken from the farthest posterior point, diagonally in a straight line to the farthest point of the anterior extremity. (Figure 65.)

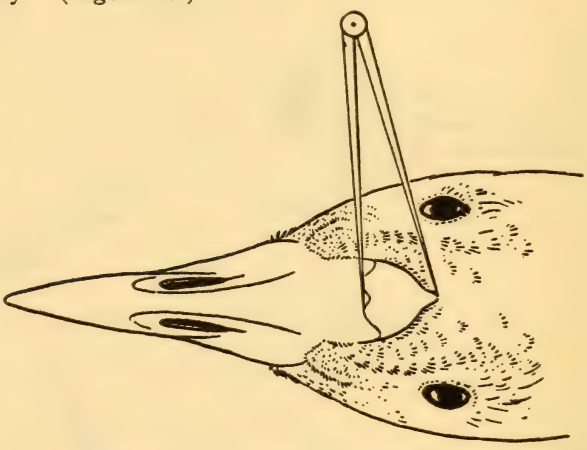

FIGURE 65.—LENGTH OF FRONTAL PLATE

Width of frontal plate.—The width of the frontal plate is measured in a straight line with dividers at its widest point. (Figure 66.)

Other measurements of the frontal plate can be taken, but the length and width seem to be the most useful.

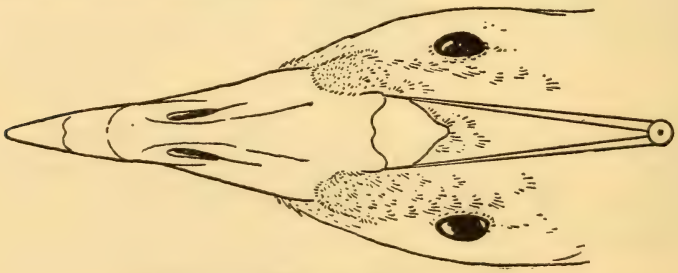

FIGURE 66.—WIDTH OF FRONTAL PLATE

Length of comb.—Head ornaments, such as the combs of gallinaceous birds (Galliformes), are usually larger and more elaborate in males.

The length of such is measured with dividers either along the base, or at some other point, whichever will give the greatest linear, approximately horizontal, dimension. (Figure 67.)

FIGURE 67.—LENGTH OF COMB

Height of comb.—The greatest height is measured from the base where the comb joins the head, to the highest point directly above. (Figure 68.)

In general these two dimensions (length and height) of a comb are sufficient, but, for minute studies, appropriate additional measurements might, of course, be made.

FIGURE 68.—HEIGHT OF COMB

Length of lappet or wattle.—The greatest length of lappets or wattles is best taken as is recommended for the length of the frontal plate (see page 50), from one end to the farthest point at the other end, even when this results in a more or less diagonal measurement, as is the case in such birds as the wattled mynas (*Gracula*). (Figure 69.)

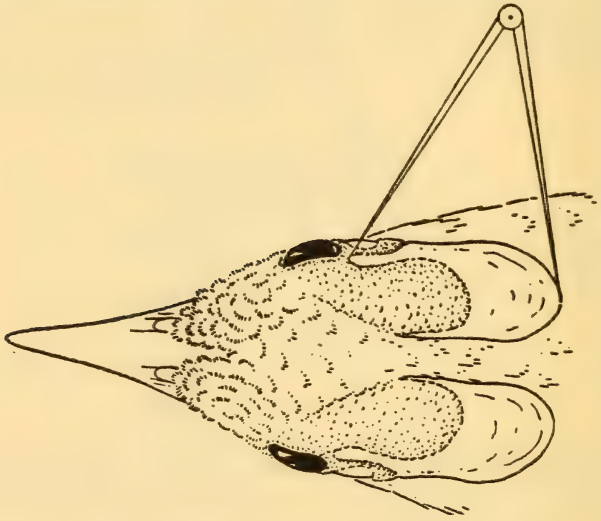

FIGURE 69.—LENGTH OF LAPPET

Width of lappet or wattle.—The width of lappet or wattle should be measured with dividers at its widest point in a straight transverse line. (Figure 70.)

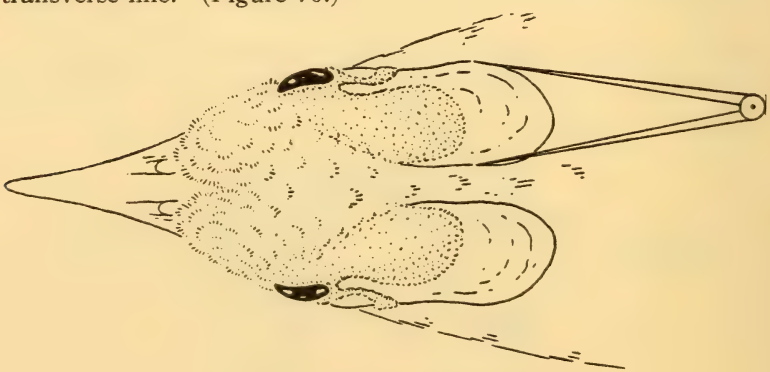

FIGURE 70.—WIDTH OF LAPPET

Length of caruncle.—Some species, such as the bellbird (*Vavasouria nivea*), possess long fleshy caruncles on the base of the bill or on other parts of the head, and the difference in the size of these is best determinable by measuring. Females in many cases possess smaller caruncles (if any) than males, and the variation in the size of this organ can thus be used as an aid in determining sex.

The length of these caruncles is most easily and accurately ascertained with dividers, as is the spur of the wing (see page 92), from the side of the base to the tip; which measurement is, therefore, the chord. (Figure 71.)

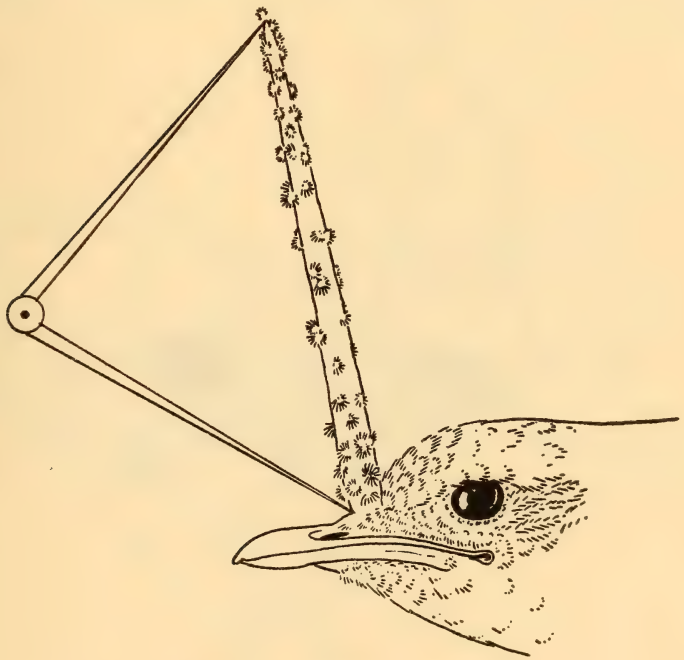

FIGURE 71.—LENGTH OF CARUNCLE

Diameter of caruncle.—The greatest diameter of the caruncle at the base and the diameter at the middle point are the best diameter measurements. These are taken with dividers exactly at right angles to the longitudinal axis of the caruncle.

Length of frontal antiae.—The length of the frontal antiae is measured from the base of the culmen, where the culmen meets the skin of the forehead, along the culmen to a point *opposite* the distal end of the longest feathers or bristles pointing forward from the forehead and overlying the culmen, the nostrils, or the sides of the maxilla, as is the situation in such birds as crows and ravens (Corvidae). This is best measured as here described, since the base of the culmen forms the most definite point of departure. (Figure 72.)

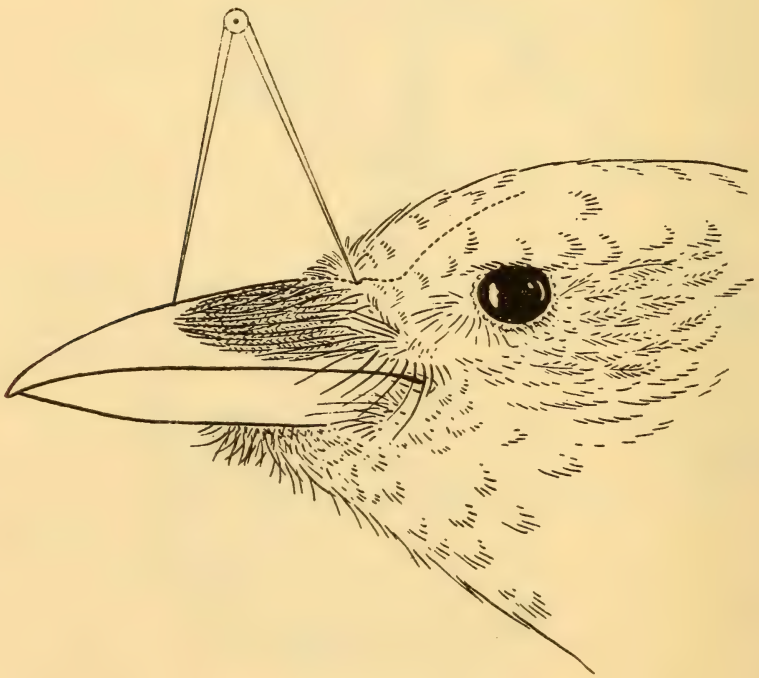

FIGURE 72.—LENGTH OF FRONTAL ANTIAE

Length of crest.—In determining the length of the frontal crest of birds such as the drongos (Dicruridae), the length of the occipital crest of birds such as the jays (Corvidae), the length of "ear" tufts of owls (Strigiformes), and the length of the head plumes of herons (Ardeidae), the longest feather is measured from the point where it emerges from the skin, to its tip. In cases where crest feathers are naturally bent or curled, they should be straightened and their greatest length ascertained. (Figure 73.)

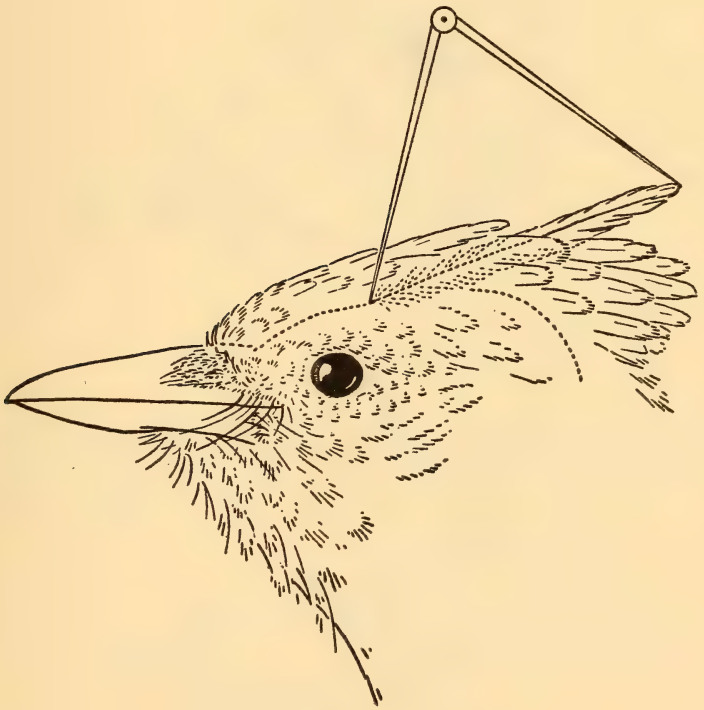

FIGURE 73.—LENGTH OF CREST

Diameter of facial disc.—The greatest diameter (Figure 74) and the least diameter of this area, which is present in such birds as owls (Strigiformes), should be taken from the tips of the outermost feathers on one side of the disc to the tips of the corresponding feathers making up the opposite side, with the feathers in their natural position.

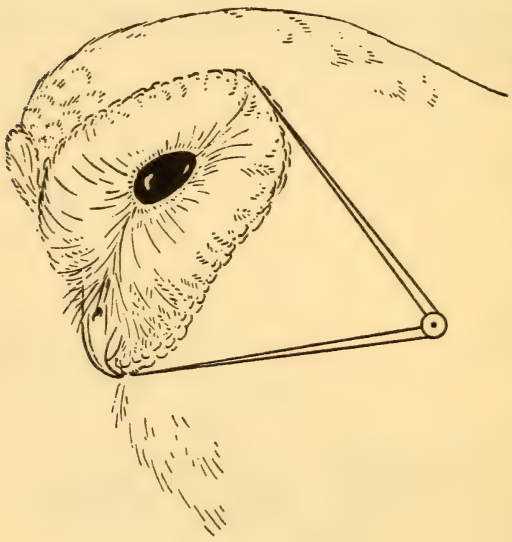

FIGURE 74.—GREATEST DIAMETER OF FACIAL DISC

NECK

Length of neck.—To measure the length of the neck, one point of the dividers is placed at the point where the neck joins the head, and the other point is pressed as far back between the neck and shoulder as the investing integument will allow, while the neck is held straight but not stretched. (Figure 75.) The exact posterior limit of the neck, however, can not be very accurately found and measured in the whole bird; and, of course, this dimension can not be taken at all from a dry skin.

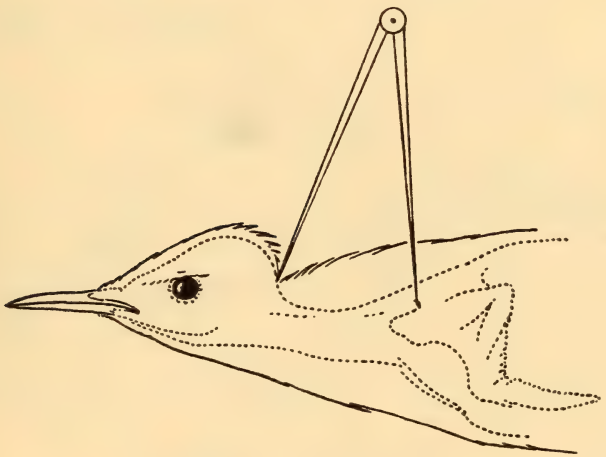

FIGURE 75.—LENGTH OF NECK

Diameter of neck.—The diameter of the neck is taken at its middle, and should be the greatest diameter at that point, exclusive of the feathers. (Figure 76.)

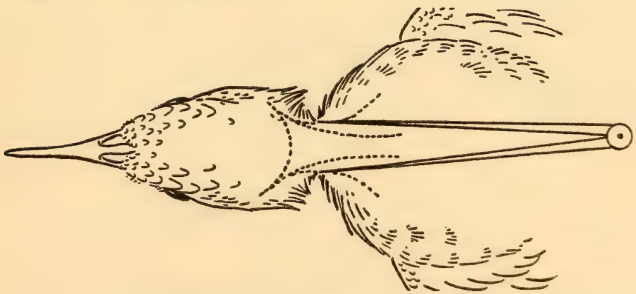

FIGURE 76.—DIAMETER OF NECK

Length of gular pouch.—The size of the fleshy gular pouch of pelicans (Pelecanidae), cormorants (Phalacrocoracidae), and other birds varies in different species and between individuals of the same species; and measurements of this part of the bird are obviously valuable, particularly if taken in the flesh.

The length of the gular pouch is best measured with dividers from the point of anterior extension on the under side of the mandible, in a straight, approximately horizontal, line to the point of unfeathered posterior extension on the side (Figure 77), and on the front (Figure 78) of the throat.

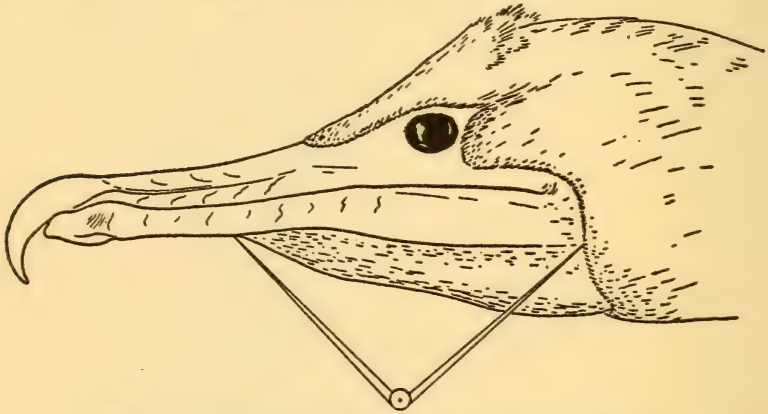

FIGURE 77. LENGTH OF GULAR POUCH TO SIDE OF THROAT

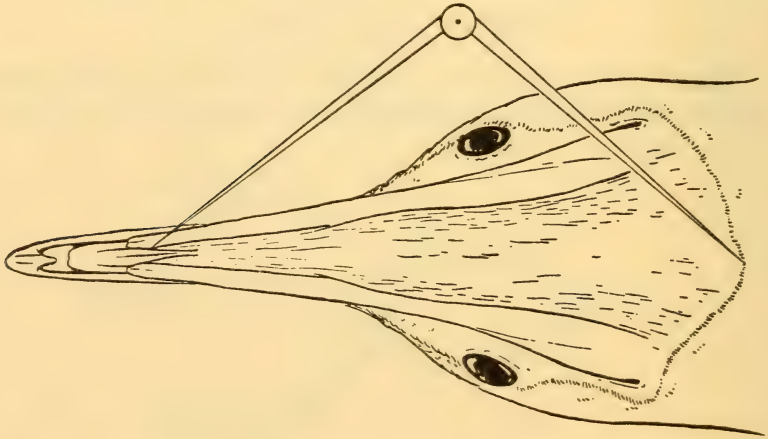

FIGURE 78.—LENGTH OF GULAR POUCH TO FRONT OF THROAT

Depth of gular pouch.—The depth of the gular pouch is ascertainable by measuring with dividers from the corner of the mouth in a straight line to the point of lowest extension of the pouch, whether on the side or front of the throat. (Figure 79.)

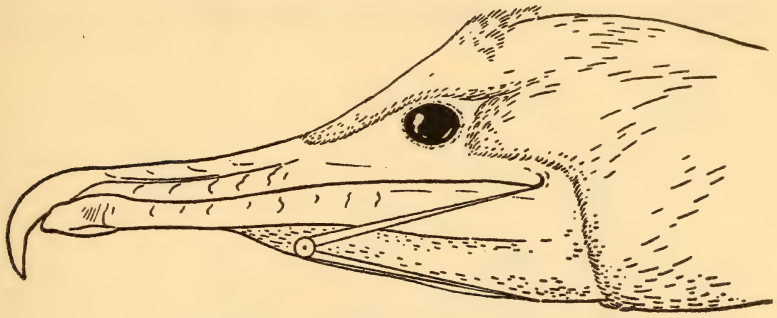

FIGURE 79.—DEPTH OF GULAR POUCH

Size of tympanum.—Tympanums, such as occur on the necks of grouse (Tetraonidae), are measured by ascertaining, when deflated, their greatest diameter (Figure 80) and least diameter, and also if possible when artificially inflated. More careful studies of these bare spots can be made by determining their exact area.

Since these spaces shrink after the death of the bird, measurements should be taken from a living individual, or one just killed.

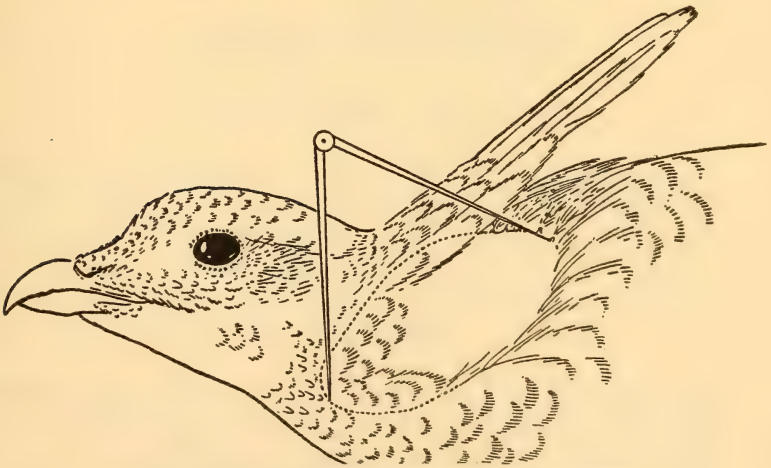

FIGURE 80.—GREATEST DIAMETER OF TYMPANUM

Length of nuchal hair.—Of the nuchal, or occipital, hairs of such birds as bulbuls (Pycnonotidae), or of elongated nuchal feathers, the longest is the important one, to be measured from base to tip, as are contour or other feathers (see page 70), and for this purpose should be straightened. (Figure 81.)

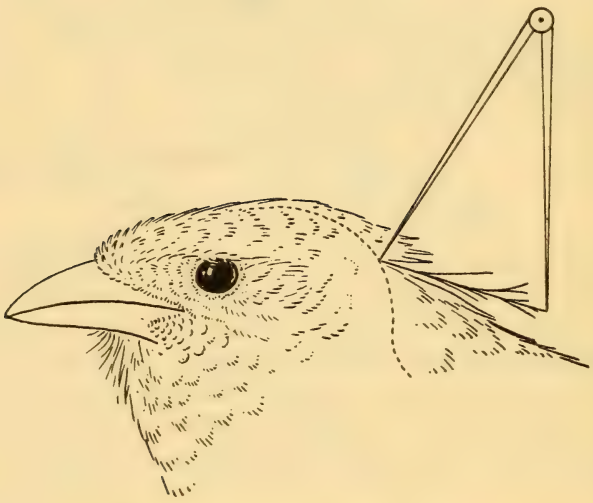

FIGURE 81.—LENGTH OF NUCHAL HAIR

Length of ruff.—The length of a neck ruff such as is present in the ruffed grouse (*Bonasa umbellus*), or a neck tuft as in the prairie chicken (*Tympanuchus americanus*), is ascertained by measurement of the length of the longest feather, straightened, from the point of its junction with the skin to its tip. (Figure 82.)

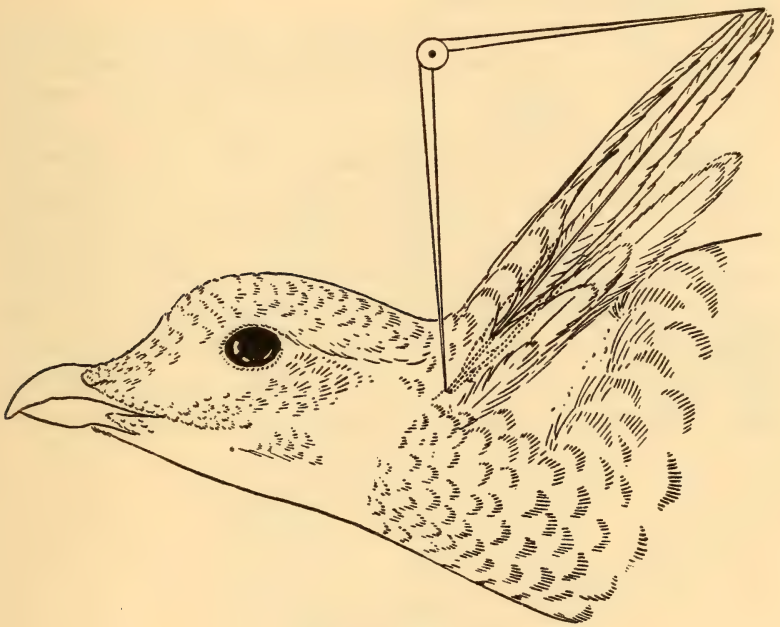

FIGURE 82.—LENGTH OF RUFF

Width of expanded ruff.—The width of an expanded ruff is to be measured in the same manner as the width of the expanded tail (see page 95), when it is spread so that the outermost feathers are at an angle of 45° with the central line of the ruff (a total expanse of 90°), and straight across the widest part of the ruff thus spread, to the farthest tips of the feathers.

Area of ruff.—The area of the ruff, spread on each side to an angle of 45°, is obtained in the same way as is the area of the tail (see page 96), by outlining the ruff from tip to tip of the feathers, on graph paper, and counting the squares in the area thus enclosed.

BODY

Measurements of the body can be obtained from the feathered bird, subject to some error caused by the feathers, but more accurately from the body when free of feathers; though not at all, of course, from a prepared skin. The body should be fully relaxed when measurements are made.

In the bird in the flesh the bones are so covered with muscle and skin that measurements can not be expected to compare in accuracy with the same measurements of the bones of the skeleton.

Length of body to coccyx.—* This is an approximate measurement of the bird exclusive of head, neck, and the tail-feathers. It is ascertained by placing one point of the dividers at the anterior margin of the shoulder and the other point at the posterior tip of the coccyx. (Figure 83.) We prefer this measurement to the length of the body to the pubis, since it is more comparable with the total length without feathers.

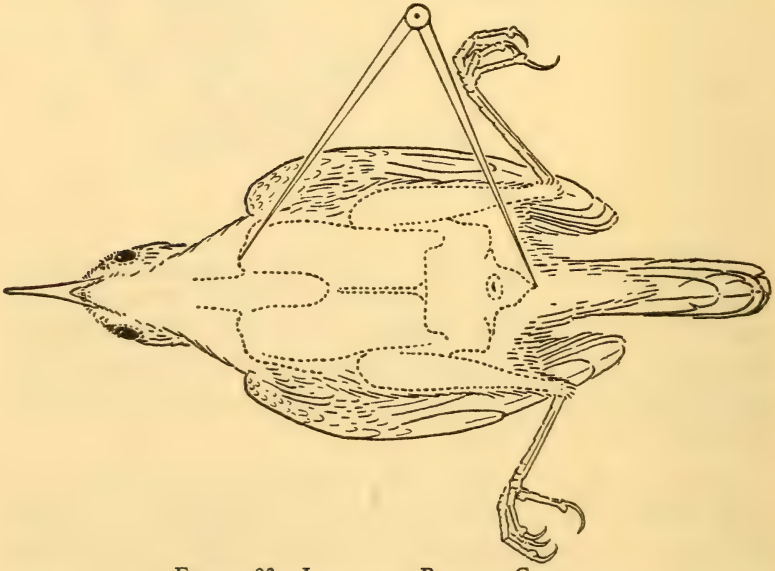

FIGURE 83.—LENGTH OF BODY TO COCCYX

Length of body to pubis.—This is also a measurement without the feathers, and is taken with one point of the dividers placed at the anterior margin of the shoulder, and the other at the posterior end of the pubic bone on the same side of the bird. (Figure 84.)

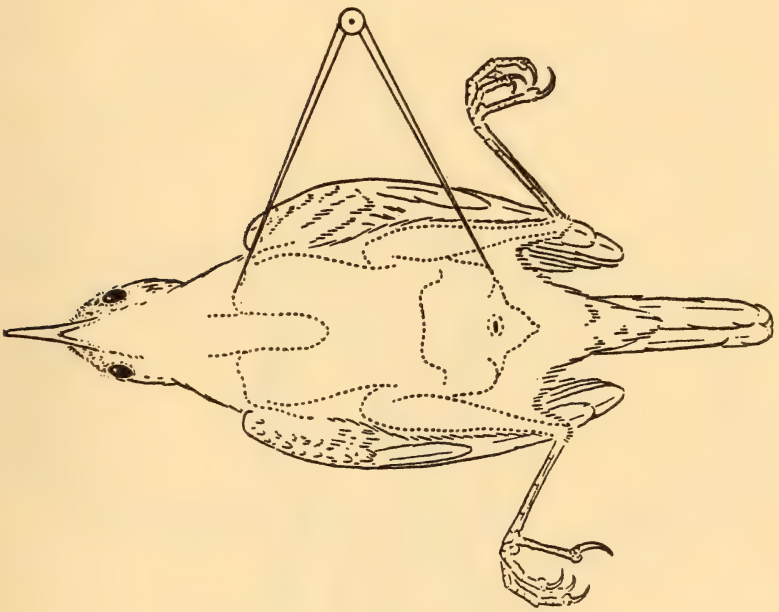

FIGURE 84.—LENGTH OF BODY TO PUBIS

Interhumeral width of body.—This measurement is the distance through the body at the widest part of the breast. It can be taken most easily when the bird is lying flat on its back with the wings spread, since then the points of the dividers can be readily placed against the shoulders beneath the wings at opposite sides of the breast underneath the feathers. (Figure 85.)

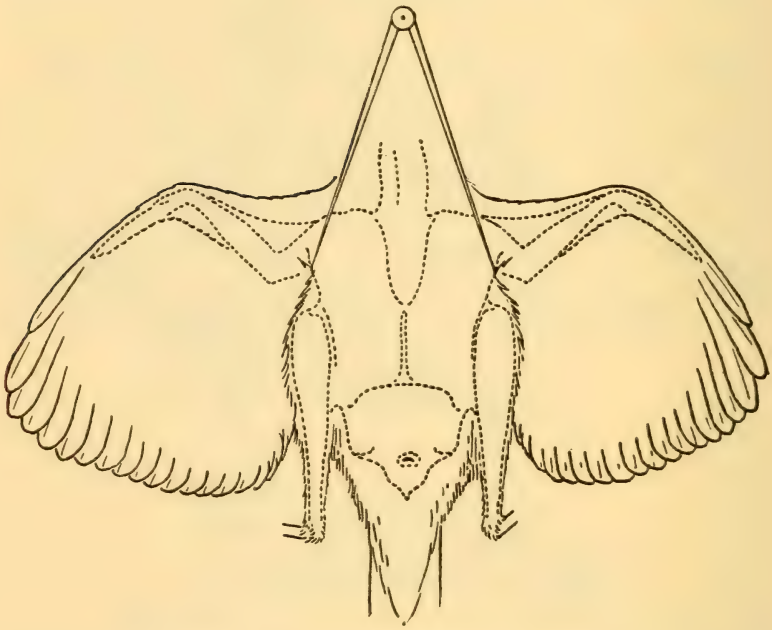

FIGURE 85.—INTERHUMERAL WIDTH OF BODY

Interpubic width of body.—The interpubic width is the greatest lateral diameter of the body at a point opposite and outside the tips of the pubic bones, and is taken with dividers. (Figure 86.)

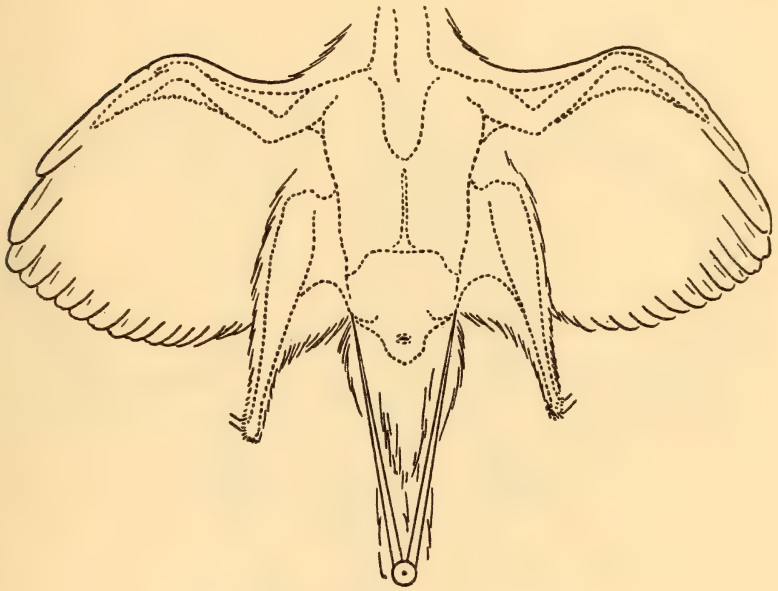

FIGURE 86.—INTERPUBIC WIDTH OF BODY

Width of body between tips of pubic bones.—The width of the body from tip to tip of the pubic bones is the distance, across the ventral surface of the abdomen, between the posterior tips, from the inner side, of the opposite pubic bones. The points for measurement may easily be found in birds in the flesh. (Figure 87.) It is best measured with dividers.

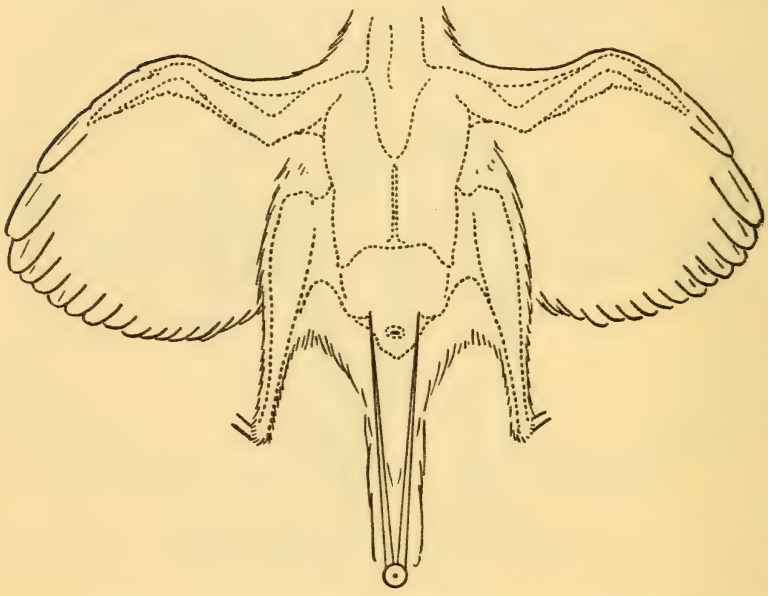

FIGURE 87.—WIDTH OF BODY BETWEEN TIPS OF PUBIC BONES

Girth of body.—This is the circumference of the body, measured by a tape at the widest part of the thoracic region. The tape should be drawn tight enough to fit snugly, but not to compress the body. The wings are not included in this measurement, but the contour feathers are. (Figure 88.) A more accurate measurement can be taken from a bird devoid of feathers.

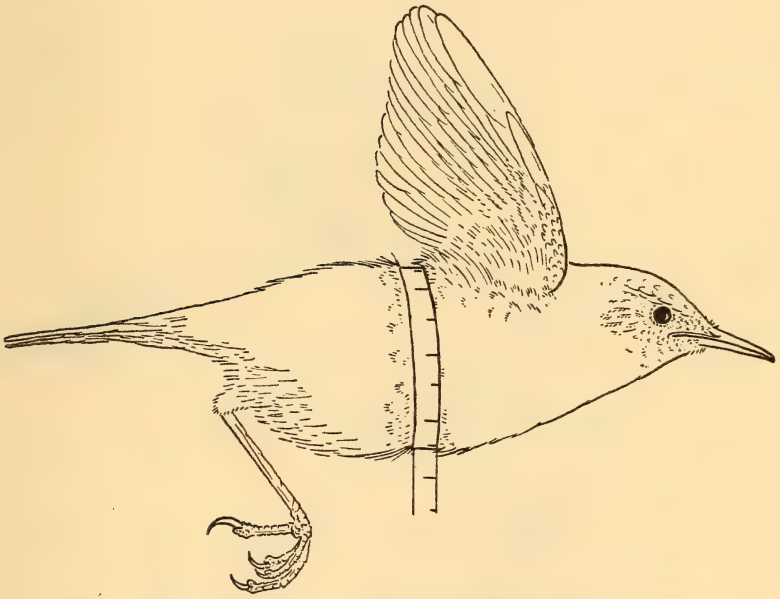

FIGURE 88.—GIRTH OF BODY

Dorso-ventral diameter of body.—This is the thickness of the body in the dorso-ventral plane, from the sternum (usually its middle part) on the ventral side, to the back; and it is measured with dividers through the thickest part of the body, not including the feathers. (Figure 89.)

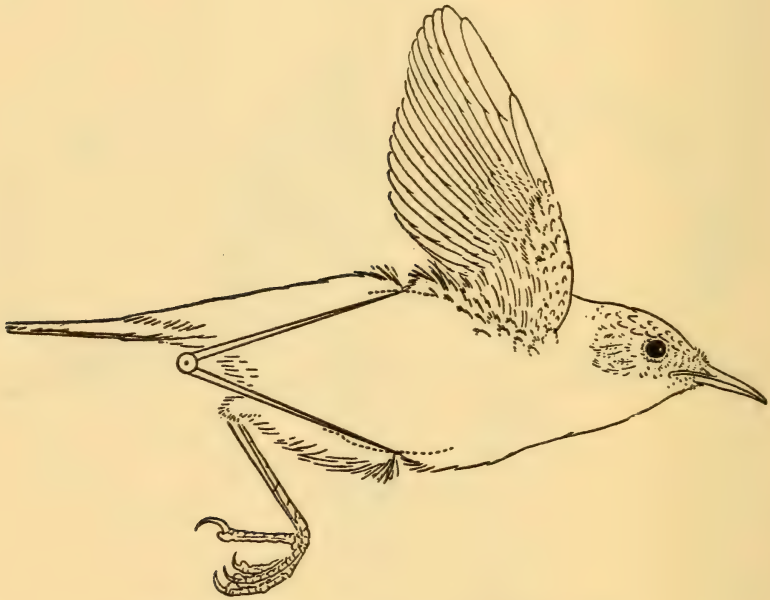

FIGURE 89.—DORSO-VENTRAL DIAMETER OF BODY

Length of sternum.—The length of the sternum is measured in a straight line from the anterior end of the manubrium to the very posterior end along the mid-ventral line. (Figure 90.) In adult male birds such a measurement can not be more than approximate without the removal of feathers from the breast, but this can sometimes be safely practised on the living bird. In females and young birds, which often lack feathering on the middle of the breast, the limits of the sternum are plainly visible through the skin. The sternum measurements can be taken while the breast is covered with feathers, by feeling the ends with the thumb and forefinger of one hand while the dividers are placed with the other. This measurement can be taken from the living bird or body of a dead bird, but not from a prepared skin.

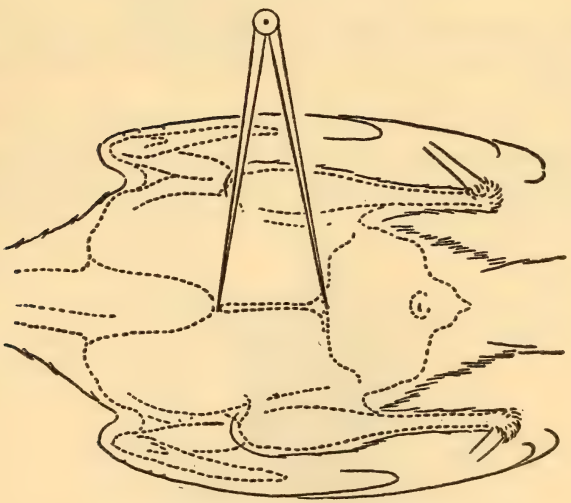

FIGURE 90.—LENGTH OF STERNUM

Length of contour feather.—The greatest length of a contour feather is measured with dividers from the point of its emergence from the skin to the farthest part of the tip, when straightened, or flattened. (Figure 91.)

FIGURE 91.—LENGTH OF CONTOUR FEATHER

Width of contour feather.—The width of a contour feather is taken from edge to edge at its widest point, the feather flattened. (Figure 92.)

Much is yet to be learned regarding the relative size of contour feathers from different parts of the same bird, and from comparison of feathers from the same tracts of different species of birds.

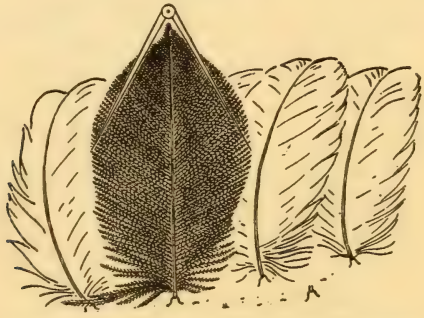

FIGURE 92.—WIDTH OF CONTOUR FEATHER

Length of markings on contour feathers.—The actual length of light or dark areas on an otherwise colored feather can be readily measured as explained for the length of such markings on the tail-feathers (see page 100).

Length of aftershaft.—The length of the aftershaft of the contour feathers of gallinaceous birds (Galliformes) and of some other birds should be measured with dividers from the extreme base of the aftershaft at its junction with the shaft of the main feather, between the latter and the aftershaft, to the tip, with the aftershaft straightened. (Figure 93.)

FIGURE 93.—LENGTH OF AFTERSHAFT

Length of down feather.—A down feather is measured for length in the same manner as contour feathers (see page 70): from the point of emergence from the skin to the tip, while *straightened*. (Figure 94.)

In the study of the development of the down plumage in young birds, measurement of the daily growth of down feathers is sometimes desirable.

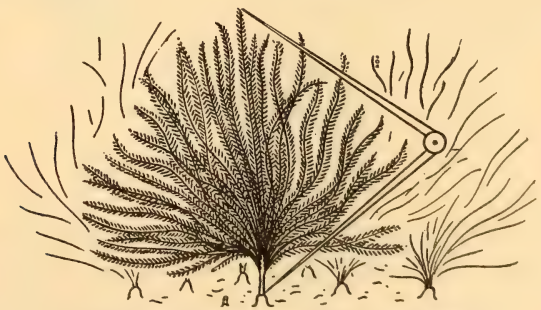

FIGURE 94.—LENGTH OF DOWN FEATHER

Length of plume.—Pectoral, nuchal, dorsal, and rump plumes, such as those of herons (Ardeidae), as well as 'wires' (the naked feather shafts of paradise birds [Paradiseidae]), show both individual and specific variation in size. The length of these is taken in the same way as that of contour feathers (see page 70), from the point of their insertion in the integument to their tips, with the shaft *straightened.* (Figure 95.)

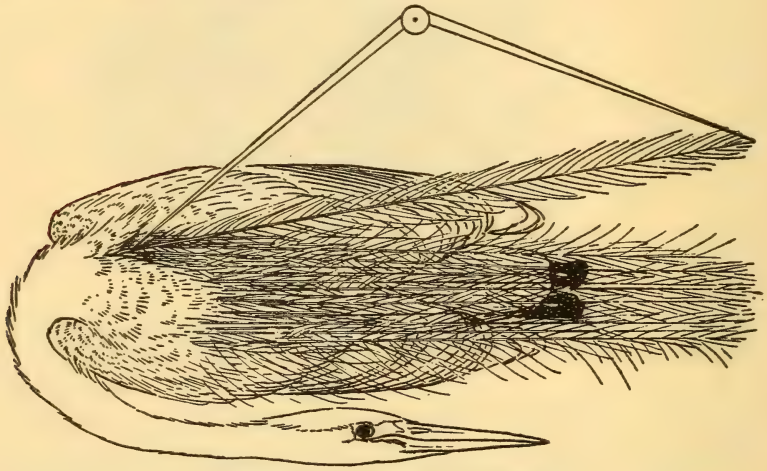

FIGURE 95.—LENGTH OF PLUME

Another method of studying proportions and additional facts about feathers is to remove them from the bird. Measurements of the **length of removed feathers** should include the entire calamus instead of only the part that in life is outside the skin; but the feathers (except primaries and secondaries) should be, of course, straightened. (Figure 96.)

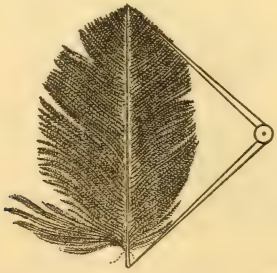

FIGURE 96.—LENGTH OF REMOVED FEATHER

Length of dewlap or other ornament.—Other body ornaments, such as the dewlap in the wild turkey (*Meleagris gallopavo*) and umbrella bird (*Cephalopterus ornatus*), offer in many cases taxonomic characters in their size. The length of such an appendage is measured from the point of insertion in the skin, and on the under side between the ornament and the body, to the tip, the ornament straightened. (Figure 97.)

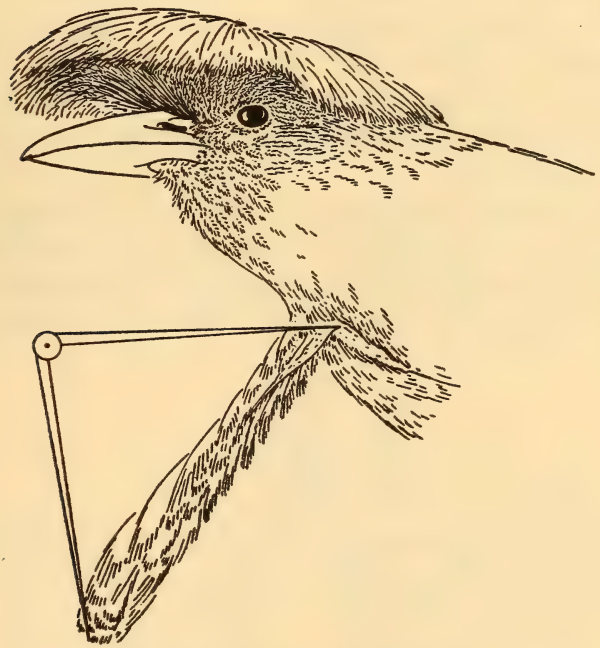

FIGURE 97.—LENGTH OF DEWLAP

Width of dewlap or other ornament.—The width of the dewlap or similar appendage is taken at its widest point, with the appendage in its natural position, that is, not spread, nor flattened, even if naturally curled.

WING

Extent of wings with feathers.—The extent of wings is the distance between the tips of the outstretched wings. It is measured from the farthest primary tip on one side to the farthest primary tip on the other, by laying the bird, thoroughly relaxed, flat on its back, and, by grasping each wing at the carpal joint, spreading the wings out along a ruler as far as possible without injuring the bird or flattening the wing-quills. (Figure 98.) For large birds that exceed any ruler available, the extreme points of extent can be marked on table or floor and the distance between these measured.

This measurement can be obtained from only the living bird or the body of a dead bird. It is subject to some little variation in judgment of the observer as to when the full extent is reached without stretching.

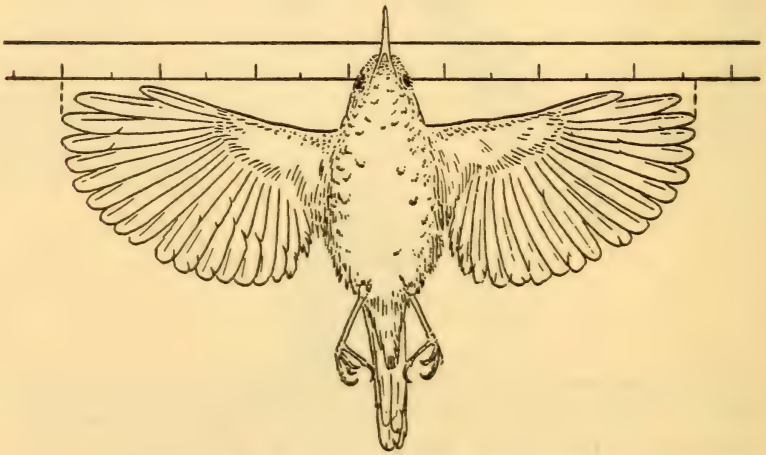

FIGURE 98.—EXTENT OF WINGS WITH FEATHERS

Extent of wings without feathers.—This is taken by holding the bird in the same position as for measurement of extent with feathers (see page 74) and measuring with ruler or dividers from the tip of the manus on one side to the tip of the opposite manus. (Figure 99.)

FIGURE 99.—EXTENT OF WINGS WITHOUT FEATHERS

Length of closed wing.—This is the wing measurement most commonly used, and is generally called 'wing' or 'length of wing' in descriptions of birds. It is preferably taken with dividers in a straight line from the farthest anterior point on the anterior edge of the wrist joint to the tip of the longest *primary*, without attempting to flatten out the curve of this feather; and it is therefore the *chord* of the closed (folded) wing. (Figures 100 and 101.)

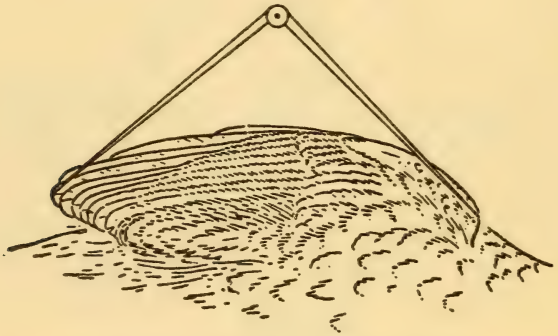

FIGURE 100.—LENGTH OF CLOSED WING

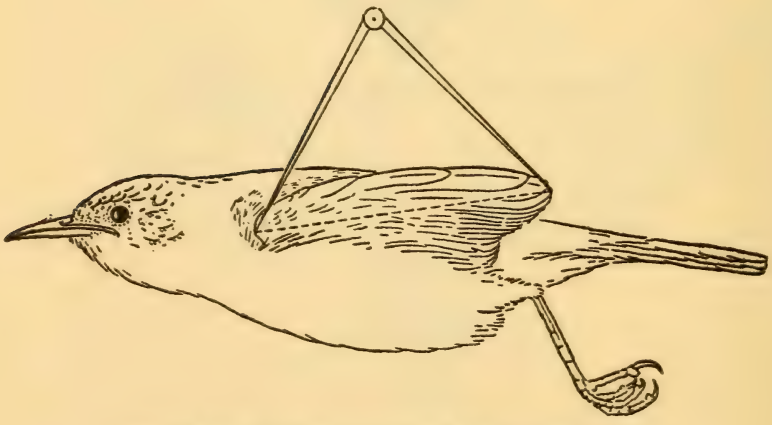

FIGURE 101.—LENGTH OF CLOSED WING FROM BELOW

Since for taxonomic purposes this measurement is ordinarily obtained from prepared skins, it is better taken always in this manner, rather than in part from the bird in the flesh, in order, for comparative purposes, to eliminate any possible differences that may be due to shrinkage of the wing in drying. When there is, as sometimes happens, a difference between the length of the right and left wings, it is well to make use of the longer.

Furthermore, in taking this measurement with dividers, care should be exercised to place one point of the dividers exactly at the farthest anterior part of the bend of the wing, and not to allow it to slip by, since this will cause an error in the result. The thumb nail placed at right angles against the bend of the wing is an aid in this operation. The same caution applies to the placing of the other point of the dividers at the end of the primaries. It is well always to measure the left wing; and this is most easily and safely handled from above. (Figure 100.) If a ruler is used for wing measuring, a vertical end piece firmly fastened to the left end of the ruler will greatly facilitate the work.

* By some European and most American ornithologists the custom has in general been to measure the wing as above described, without flattening out the curve of the primaries. For this particular measurement we prefer this method as more likely to be accurate, besides being easier to take, unless with a specially constructed ruler. *However, for other measurements of feathers, except those of primaries and secondaries, we recommend straightening the shaft.*

By some ornithologists, however, the method often used is to flatten the primaries along a ruler, and thus to obtain the maximum length of the wing. It is probably unnecessary to mention that

this method gives a longer measurement than if the primaries are left in their natural position, and that due allowance must be made in comparing measurements taken thus differently.

Another way of measuring the length of the wing is by means of a tape placed along the arc formed by the primaries. This is approximately the same as the measurement of the flattened primaries, but is more subject to error, and therefore unsatisfactory. *Whichever method is used in wing measurement should in any case be clearly stated.*

Length of open wing.—This is the length of one wing from the point of juncture with the body of the bird to the farthest tip of the primaries while the wing is outstretched. It is measured in a straight line by placing one point of the dividers at the point where the anterior edge of the wing joins the skin of the body, and the other point at the tip of the longest primary. This, too, is the chord. (Figure 102.)

This measurement can be taken better from the living bird or the dead body than from the dried wing; and of course not at all from a scientific skin as ordinarily prepared.

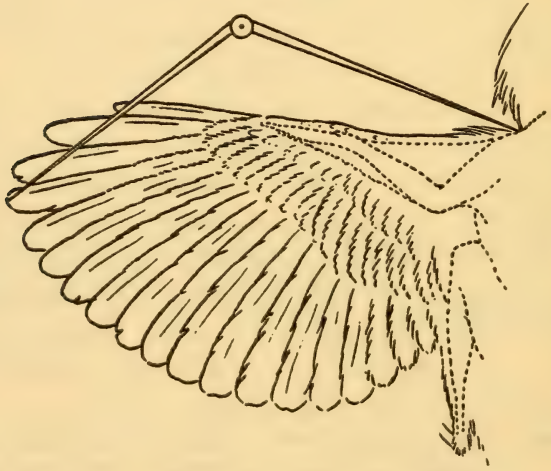

FIGURE 102.—LENGTH OF OPEN WING

Breadth of wing at outermost secondary.—When the wing is fully extended, with the first primary at approximately right angles to the bird's body, the breadth (width), of the wing at the outermost secondary can be measured with dividers in a straight line parallel to the axis of the body, from the anterior margin of the wing to the tip of the outermost secondary, without flattening the feathers. (Figure 103.)

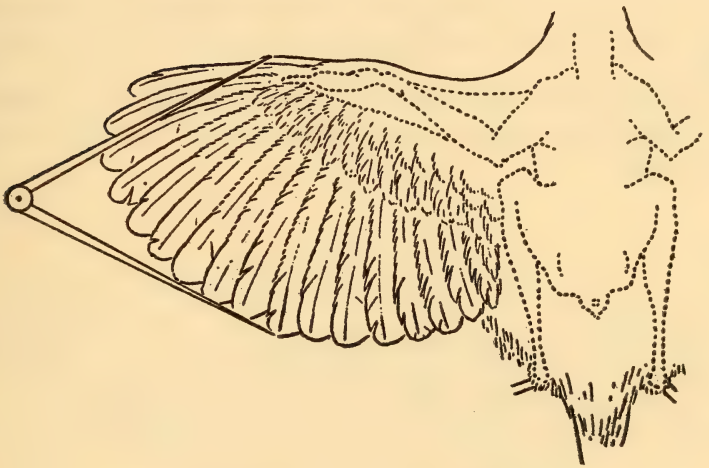

FIGURE 103.—BREADTH OF WING AT OUTERMOST SECONDARY

Greatest breadth of wing.—* The greatest breadth of the wing is, however, usually not at the outermost secondary, for in most birds the outer secondaries are shorter than some of the others. In birds that have the secondaries longer than the tertials this measurement of greatest breadth can be taken in the same manner as the breadth of the wing at the outermost secondary (parallel to the axis of the body of the bird), from the anterior edge of the wing straight across the secondaries to their tips where the wing is widest, which point may be at about the middle of the secondaries, or near the inner margin of the wing. (Figure 104.) If, however, the tertials be longer than the secondaries, the greatest breadth of the wing will be along its inner margin. (See Figure 105.)

In case the area of the primaries is wider than that of the secondaries, this measurement should be taken in the same way across the primaries.

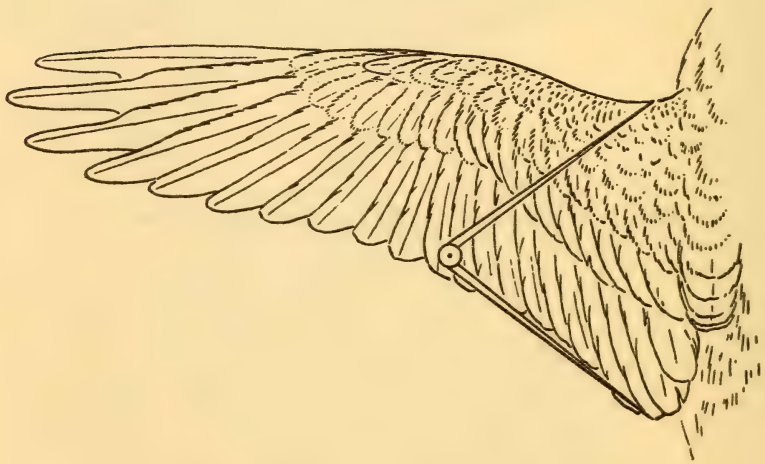

FIGURE 104.—GREATEST BREADTH OF WING

Breadth of wing at inner margin.—The breadth of the wing at the edge nearest the body is measured from the anterior margin where the wing joins the body, to the tip of the longest tertial, a measurement that is most different from the middle breadth in birds that, like plovers (Charadriidae), have the tertials much elongated, in which case, however, it does not represent the potential breadth of the wing. (Figure 105.)

If only one measurement of the breadth of the wing be used, it should be preferably the greatest breadth other than the breadth at the inner margin, since, of course, the greatest potential breadth is the most important, the other measurements of breadth being of interest chiefly as showing variations in the contour of the wing. Whichever measurements be taken should, however, be clearly stated.

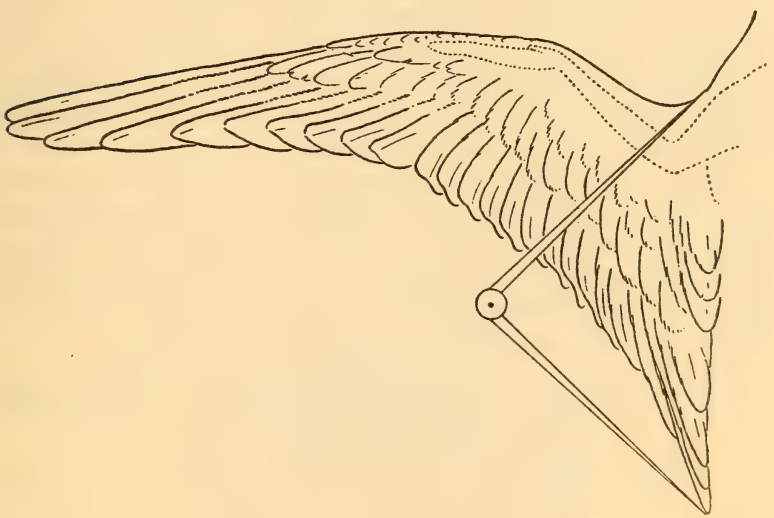

FIGURE 105.—BREADTH OF WING AT INNER MARGIN

Area of wing.—* In studies of the wing area of the house wren, the investigators at the Baldwin Bird Research Laboratory have taken their measurements from the wing so spread that the first primary is at right angles to the body, with the remaining primaries and the secondaries extended naturally and uniformly without straightening the primaries. The wing may then be outlined in pencil upon graph paper, the lines passing by the shortest distance from the tip of one feather to that of the next, even if the feathers be separated terminally. (Figure 106.) The area thus enclosed may be ascertained by counting the squares of the graph paper or by use of a planimeter. Another method of determining the area is to cut out from the paper the outline of the wing, weigh it, and compare the weight with the weight of a piece of the same paper of known area, such as 100 square centimeters.

This method of measuring by outlining the wing area from tip to tip of the feathers, thus enclosing small open areas between the tips of the wing-quills, we recommend as the more practical because more easily followed. If desired, however, for more intensive investigations, the exact area of the feathers can be measured by tracing the actual outline of the wing, following around the actual outline of the terminal portion of each of the feathers. This may best be done by means of a planimeter.

Headley in his book, 'The Flight of Birds' (1912), has called attention to the fact that the area of wing surface that a bird uses in its effective beat is of great importance in keeping the bird aloft. This writer gives figures from de Lucy, who computed the area of the wings of several species of birds and found a remarkable variation in the weight supported per unit of wing surface.

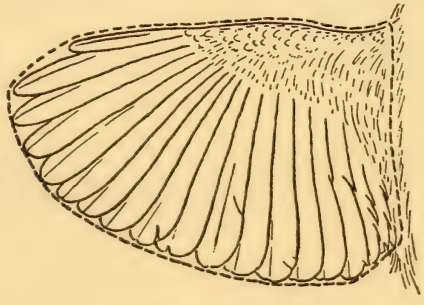

FIGURE 106.—AREA OF WING

Curvature of the wing.—When the wings of most birds are spread they display a decided concavity underneath, although those of certain species such as swallows (Hirundinidae) are remarkable for their flatness. This curvature in the spread wing is both antero-posterior and intero-exterior; the former caused by the curve of the secondaries and the inner primaries, the latter by the curve of the outermost primaries plus the curve of the anterior edge of the wing. If the curve of the wing be an arc of a circle, the exact ratio of curvature may be obtained for each wing by measurement of the chord of the spread wing and the sagitta of that chord, and substituting these measurements in the following equation:

$$\frac{1}{R} = \frac{8\ S}{C^2 + 4\ S^2}$$

In which, R = radius of the circle of which the arc is a part; C = chord; S = sagitta; $\frac{1}{R}$ = curvature.

When the curve of the wing is only an irregular arc, the curvature may still be obtained by this method, but the result is only an approximation. In making this measurement the wing is spread in exactly the same manner and to the same extent as in obtaining the wing area (see page 82). The chord is measured by means of a ruler, the sagitta by dividers or by a ruler perpendicular to the chord. The antero-posterior chord is taken from the anterior edge of the wing at the wrist joint to the tip of the secondary at the point directly posterior. (Figure 107.) The intero-exterior chord is measured from the point where the wing joins the body to the tip of the longest primary. (Figure 108.)

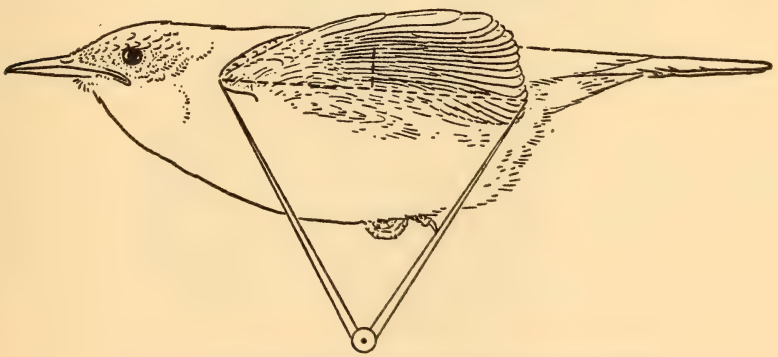

FIGURE 107.—ANTERO-POSTERIOR CURVATURE OF WING

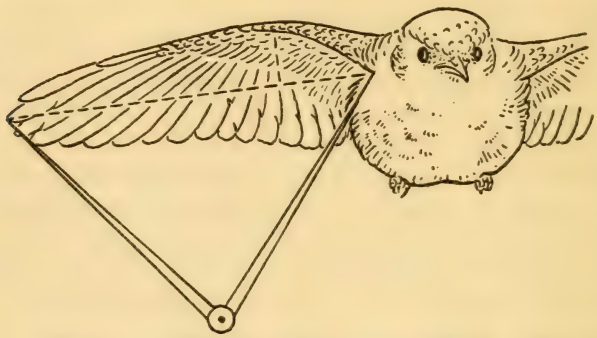

FIGURE 108.—INTERO-EXTERIOR CURVATURE OF WING

Length of upper arm (humerus).—The length of the upper arm is difficult to measure accurately in a bird in the flesh, alive or dead; but it can be done by placing the bird with its head toward the observer and the breast upward, and taking the measurement from the ventral side, with dividers, from the upper or anterior point of the humerus in the shoulder joint to the farthest projection of the humerus at the elbow joint. (Figure 109.)

FIGURE 109.—LENGTH OF UPPER ARM

Length of forearm (radius-ulna).—This, in a bird in the flesh, is measured in a straight line with dividers from the anterior outer end of the ulna, where it joins the humerus, to the farthest posterior point of the ulna or radius in the wrist joint. (Figure 110.) These points may often be readily seen through the skin from the inner side of the wing.

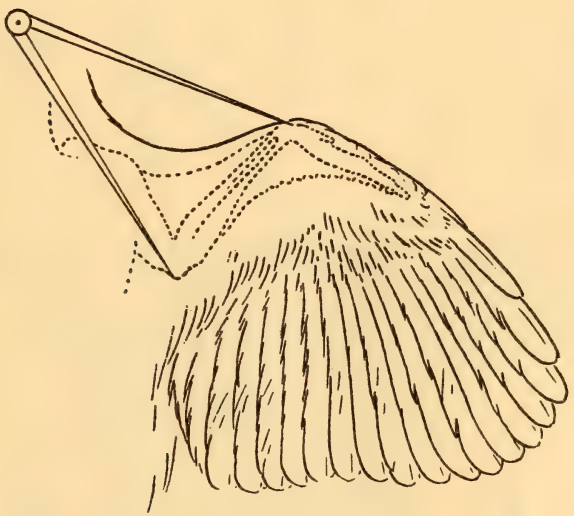

FIGURE 110.—LENGTH OF FOREARM

Length of hand (manus).—This measurement is taken in the same manner as that of the length of the forearm (see page 85), from the proximal end of the metacarpus to the extreme distal end of the longest phalanx. In the bird in the flesh this is from the wrist joint to the tip of the longest papilla to which a primary is attached. (Figure 111.)

FIGURE 111.—LENGTH OF HAND

Length of wing-tip.—The length of the tip of the wing is to be measured with dividers when the wing is closed, in a direct line from the tip of the longest primary to the tip of the longest secondary; or, in birds such as plovers (Charadriidae), which have the tertials longer than the secondaries, to the tip of the longest tertial. (Figure 112.)

FIGURE 112.—LENGTH OF WING-TIP

Distance from tip of longest primary to tip of shortest secondary.—This measurement is taken in the same way as the length of the tip of the wing. It is often mentioned in descriptions of birds; and in the swallows (Hirundinidae) it is used as a family character. (Figure 113.)

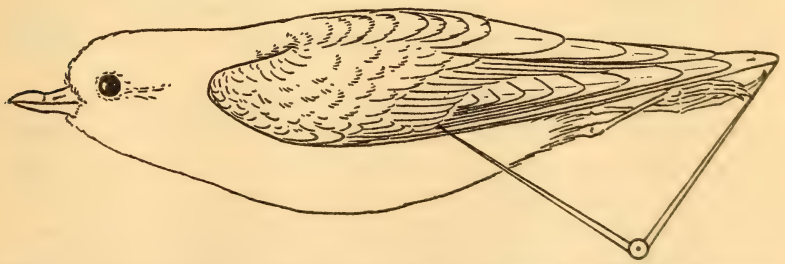

FIGURE 113.—DISTANCE FROM TIP OF LONGEST PRIMARY TO TIP OF SHORTEST SECONDARY

Length of primary.—All measurements of primaries should be made in exactly the same way. The *length of a primary quill* should be taken from the point of emergence of the shaft from the skin, to the extreme tip, in a direct line, with dividers, the feather *not straightened.* (Figure 114.)

Birds have nine, ten, or eleven primaries. In working out wing formulas of relative primary lengths it is often desirable to measure all the primaries to show the exact amount of difference. In some studies, however, it might be sufficient to measure only some of the primaries, such as the first (counting from the outermost); the second, third, fifth, or longest, whether it be the fifth or not; and the last, whether it be the ninth, tenth, or eleventh.

We recommend taking all measurements involving primaries or secondaries with the feathers not straightened, or flattened; but measurements of all other feathers with the feathers straightened, or flattened.

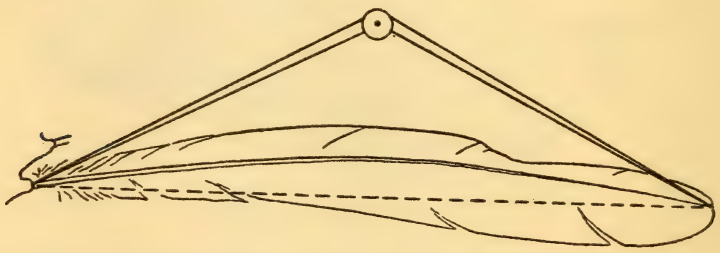

FIGURE 114.—LENGTH OF PRIMARY QUILL

Length of secondary.—The length of single secondaries is measured in exactly the same manner as the length of primaries (see page 88), the feather *not straightened, or flattened.*

Since there is often much difference in the length of the several secondaries, the measurements of these are likely to be of interest.

Length of tertial.—The length of tertials should be taken as is a primary or secondary (see page 88), except that they should be straightened, inasmuch as these feathers are, in some birds, such as the black swan (*Chenopis atrata*), so strongly curved that a measurement otherwise taken would indicate little or nothing.

In recording the measurements of single primaries, secondaries, or tertials by number, explanation should always be made of the

manner of counting, whether from the outermost or innermost. We prefer to count even the primaries from the outermost, since this method is less liable to error and is more easily used in descriptions and comparisons; although the strictly correct morphological method would be to count the primaries from the innermost, at the wrist, and the secondaries (including the tertials) from the outermost at the same point.

Width of primary.—The whole width of a primary quill is taken at its widest point from one edge of the feather to the other, at right angles to the shaft, with the vanes not flattened. (Figure 115.)

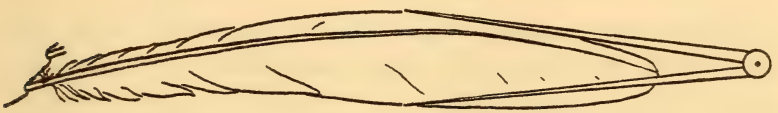

FIGURE 115.—WIDTH OF PRIMARY QUILL

Width of outer vane of primary.—The width of the outer (anterior) vane of a primary is measured at right angles to the shaft at the widest part of the vane, as is the width of the whole feather (see page 89), but from the outer edge to the shaft, not including the shaft, and with the vane not flattened. (Figure 116.)

FIGURE 116.—WIDTH OF OUTER VANE OF PRIMARY QUILL

Width of inner vane of primary.—The width of the inner (posterior) vane of a primary is taken at the widest point of this vane, as is the width of the outer vane, and in the same manner (see page 89), not including the shaft of the feather, the vane not flattened. (Figure 117.)

FIGURE 117.—WIDTH OF INNER VANE OF PRIMARY QUILL

Width of secondary.—The width of the whole feather and **the width of outer and inner vanes of a secondary** are measured in the same way as are these parts of the primaries (see pages 89–90).

Width of tertial.—The width of the whole feather, and the **width of both the inner and the outer vanes of a tertial,** are ascertained in the same manner as for the primaries (see pages 89–90), but with the vanes flattened.

The separate widths of the two vanes of feathers are generally of most interest in the primaries, secondaries, alula, some wing-coverts, and rectrices, since for the most part other feathers will show little or no essential difference between the width of outer and inner vanes.

A great number of measurements might be made of the wing-feathers, as of the other feathers of a bird. Studies to show the growth of the wing-feathers should include measurements of the length and width of primaries; secondaries; tertials; primary, greater, median, and lesser coverts; scapulars; and axillars. For studies of variation between species and among individuals, measurements of certain primaries, the longer secondaries and tertials, the longest primary covert, the longest greater covert, the longest median covert, the longest and the shortest lesser covert, the longest scapular, and the longest and shortest axillars are suggested as likely to be of interest.

Length of wing plume.—Wing plumes, which would include the marvelously developed primaries of the pennant-winged nightjar (*Macrodypteryx longipennis*), are measured from the point of emergence from the skin, to the tip, *straightened*, in the same manner as down feathers (see page 71).

Difference between length of first primary and primary coverts.—In birds that possess a spurious first primary, the difference in length between this and the primary coverts as they lie in their natural position is taken in a straight line from a point *opposite* the tip of the longest primary covert to a point opposite the tip of the first primary, so that this measurement will be parallel to the longitudinal axis of the other primaries, not parallel to the longitudinal axis of the whole wing. (Figure 118.) In such measurements it should be stated which is the longer, the primary coverts or the first primary.

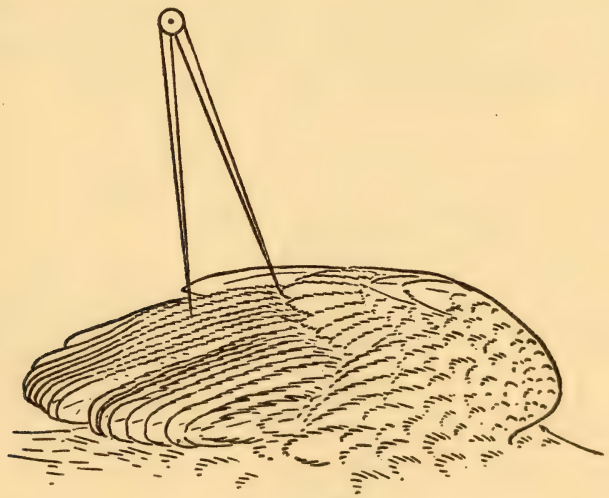

FIGURE 118.—DIFFERENCE BETWEEN LENGTH OF FIRST PRIMARY AND PRIMARY COVERTS

Length of wing spur.—The length (that is, the chord) of the spur on the bend of the wing in the jacanas (Jacanidae), certain plovers (*Belonopterus, Lobivanellus, Hoplopterus, Xiphidiopterus*, etc.) is measured in a straight line, with dividers, from the side of its base to its apex. (Figure 119.)

FIGURE 119.—LENGTH OF WING SPUR

TAIL

Length of tail.—* The length of the tail is measured with dividers, one point being inserted between the two middle rectrices at the place where their bases emerge from the skin, and the other point of the dividers brought into contact with the tip of the longest tail-feather when the tail is *closed*. (Figure 120.)

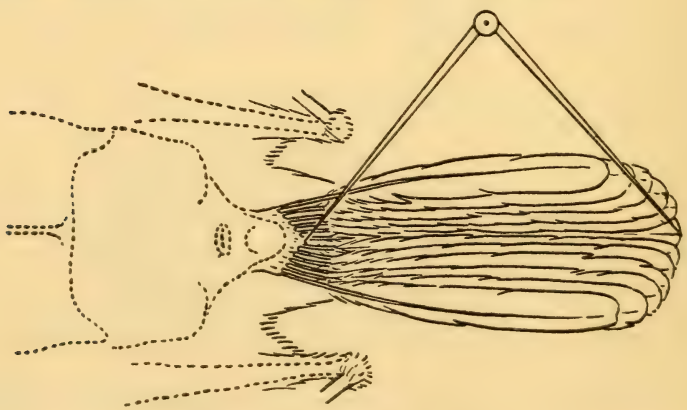

FIGURE 120—LENGTH OF TAIL

If the longest feathers are bent, curved, or curled, they should be straightened for measuring. In such birds as the king bird of paradise (*Cicinnurus regius*), in which the longest tail-feathers have tightly curled tips, it is well to take the length of the tail also without straightening these feathers, to show the difference.

Note should be made if the tail-feathers show abrasion, since in such case the tips may be worn off and the length thereby considerably changed.

In taking this measurement of the tail, much care is needed in placing the anterior point of the dividers so that this rests exactly at the base of the middle rectrices; since if the point slips beyond, an error will result. Also the other point of the dividers must be exactly in contact with the tip of the tail-feather measured, in order to produce a correct measurement. As in the case of the wing, the tail is best measured from above. If the tail to be measured is too long for the spread of the dividers, place one arm of the dividers at the point of insertion of the middle rectrices, allowing it to extend upward at right angles to the tail, and using this as the starting point measure with a ruler to the end of the tail. Or, by parting the feathers at the base of the tail expose the insertion point of the middle pair of rectrices, from which, with a ruler, measurement can be made to the end of the tail. With proper care, the measurement of the length of the tail from the insertion of the middle rectrices is without much doubt the most accurate one that can be devised.

Other methods of measuring the length of the tail, such as with a ruler from the tip of the coccyx below, or from the middle of the coccyx above, to the end of the rectrices, are subject to much greater variation and consequent error, for which reason we prefer the first method described above.

Length of tail without longest feathers.—In birds that, like tropic-birds (Phaethontidae) and some hummingbirds (*Spathura*, *Topaza*, etc.), show great variation in the length of the different tail-feathers, particularly if the outer pair or the middle pair is much longer than the rest, measurement of the length of the tail to the tips of the next longest rectrices should also be made, starting from the point of basal insertion of the middle pair of rectrices in the same manner as the regular length of the tail is taken (see page 92), but to the tips of the particular feathers to be measured, with these feathers *straightened*. (Figure 121.)

In the case of some birds that have the lateral or other rectrices very much shorter than the longest, as the woodpeckers (Picidae), the **length of the short outermost feathers of the tail** may be measured as well as the total length of the tail; but it seems to us that in most other birds the difference in the length of the tail-feathers thus ascertained is better shown by the measurement of the graduation of the tail (see page 98), or by that of the depth of the fork of the tail (see page 98), as the case may be.

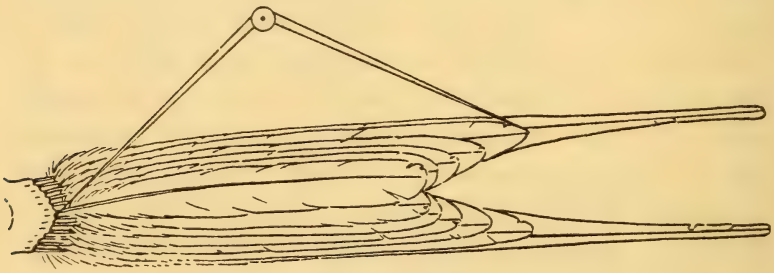

FIGURE 121.—LENGTH OF TAIL WITHOUT LONGEST FEATHERS

Width of tail at base.—The width of the tail at base can be measured from the point of insertion of the outer tail-feather of one side to the corresponding point on the other side. (Figure 122.)

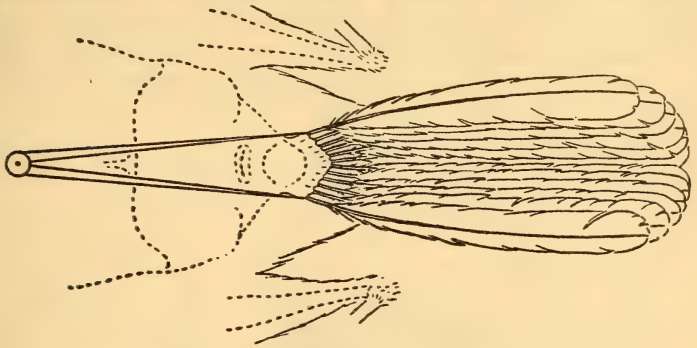

FIGURE 122.—WIDTH OF TAIL AT BASE

Width of expanded tail.—This is the width of the tail at its widest point, and is best measured with the tail spread on each side to an angle of 45 degrees with the longitudinal axis of the body (a total of 90 degrees), and the distance straight across this ascertained between the ends of the feathers that will give the greatest width. This will usually be from the tip of the outermost rectrix on one side to the tip of the corresponding feather on the opposite side (Figure 123), unless these feathers are much shorter than the rest.

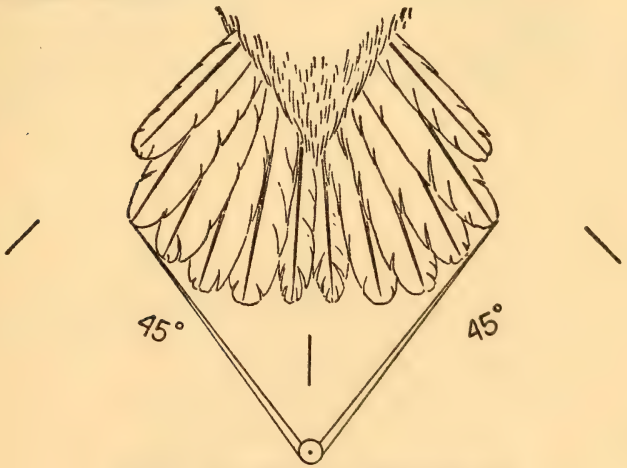

FIGURE 123.—WIDTH OF EXPANDED TAIL

Area of expanded tail.—This is most satisfactory if taken with the tail expanded to an angle of 45 degrees on each side (so that the outermost feathers make an angle of 90 degrees with each other), and the area of the tail outlined on graph paper as in ascertaining the area of the wing (see page 82), by drawing a line around the tail from tip to tip of the feathers. (Figure 124.)

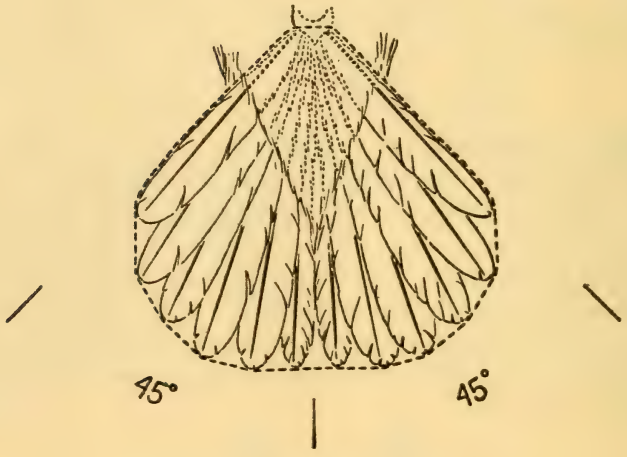

FIGURE 124.—AREA OF EXPANDED TAIL

In the case, however, of a tail with very long outermost feathers, the outline would, of course, not pass from the tip of the long outermost feather on one side to the tip of the long feather on the opposite side, but around these feathers, and across the tips of the short feathers. (Figure 125.)

If the central feathers be much longer than the others, the line would, of course, pass across the tips and around the lateral margins of these long feathers, and across the tips of the others.

After the area is outlined on graph paper, the area of the figure obtained may be determined by counting the squares, or by weighing the figure as cut out of the paper and comparing it to the weight of a piece of the same paper of known area. As in the case of the area of the wing (see page 82), this measurement is possible from only a living bird or a dead bird in the flesh.

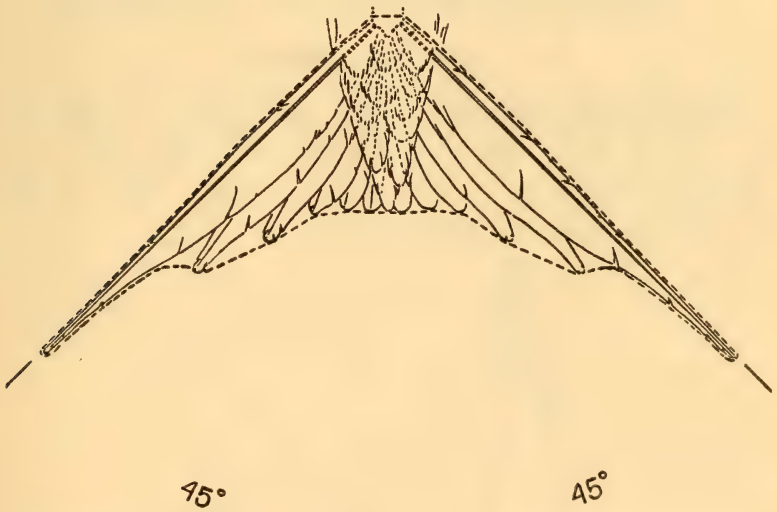

FIGURE 125.—AREA OF EXPANDED TAIL WITH LONG OUTERMOST RECTRICES

Depth of fork of tail.—The depth of the fork of a furcate tail, like the tails of most terns (Sternidae), should be measured from the apex of the fork to the tip of the longest tail-feather, when the tail is *closed*. (Figure 126.)

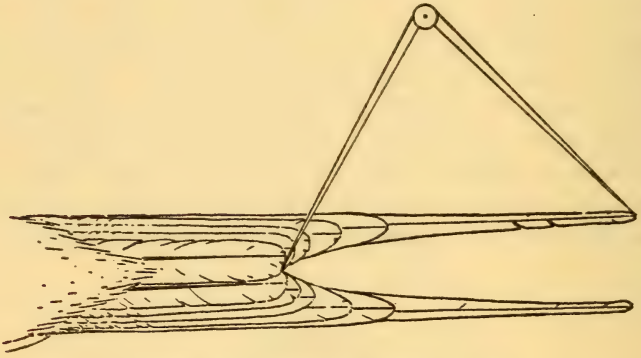

FIGURE 126.—DEPTH OF FORK OF TAIL

Graduation of tail.—The graduation of the tail should be measured with dividers from the tip of the shortest rectrix to the tip of the longest, while the tail is entirely closed. (Figure 127.)

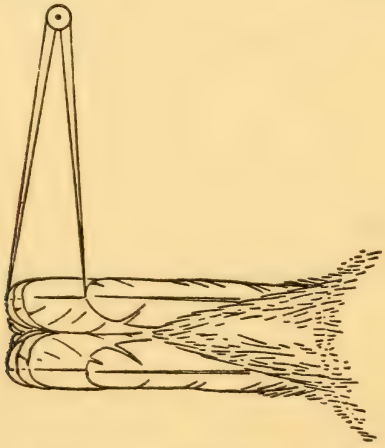

FIGURE 127.—GRADUATION OF TAIL

Length of tail-feather.—In case it is desirable to measure the length of individual feathers of the tail, such should be measured as are individual contour feathers (see page 70), from the insertion at the base, to the tip, with the shaft straightened.

Width of tail-feather.—The width of each rectrix is best determined at the widest point, with dividers, at right angles to the shaft, from one edge of the feather to the opposite edge, with the feather flattened, but otherwise in the same manner as the width of wing-quills is measured (see pages 89–90; Figure 115).

Width of outer vane of tail-feather.—The width of the outer vane of a tail-feather is taken at the widest part of the outer vane, and at right angles to the shaft, from the outer edge of the vane to the shaft, not including the shaft, as the vane of a wing-feather is measured (see page 89; Figure 116), but with the vane flattened.

Width of inner vane of tail-feather.—The width of the inner vane of a tail-feather is ascertained as is the width of the outer vane, and also at the widest point (see page 99).

Length of spot on tail-feather.—The length of light or dark spots or other markings on the rectrices should be measured as is the horizontal length of the bill (see page 14), to show the actual linear distance parallel to the shaft of the feather, not the chord of the length of the area. This means that the measurement must be taken in a straight line from *opposite* one end of the differently colored area to a point opposite the other end. (Figure 128.)

The same method, of course, applies to the measurement of similar markings on the feathers of the wing, or on contour feathers.

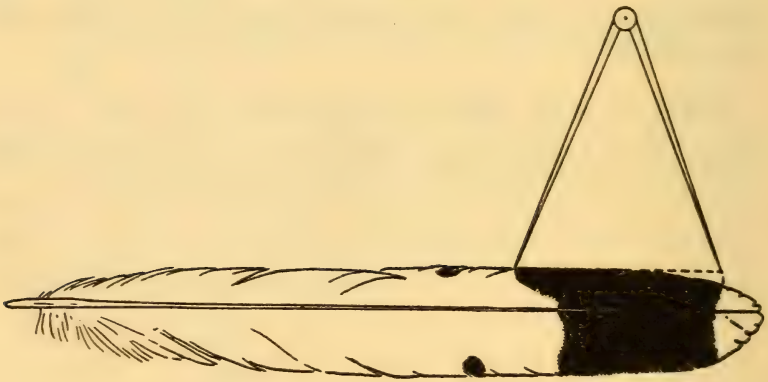

FIGURE 128.—LENGTH OF SPOT ON TAIL-FEATHER

Length of tail-racket.—The greatest length of a tail-racket should be measured with dividers, the racket flattened, from the extreme base (the proximal end) along the shaft (even though this part of the racket be much narrowed) to the tip. (Figure 129.)

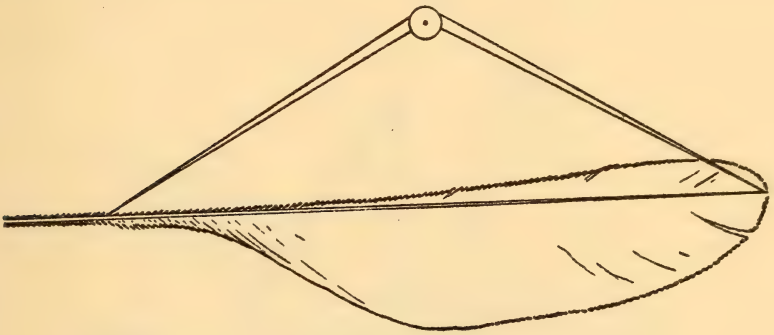

FIGURE 129.—LENGTH OF TAIL-RACKET

Width of tail-racket.—The width of a tail-racket is taken at the widest point, from edge to edge at right angles to the shaft, with the racket flattened. (Figure 130.)

The size of the tail-racket has proved of subspecific importance in the drongos (Dicruridae) and hummingbirds (Trochilidae), and may be useful in other birds.

FIGURE 130.—WIDTH OF TAIL-RACKET

Length of upper tail-coverts.—In birds that have the upper tail-coverts greatly modified, as in the peacock (*Pavo cristatus*), the length of the longest feather (that is, the feather the tip of which extends farthest posteriorly) should be measured from the point of emergence from the skin to the tip; but if bent or curled the feather should be straightened. (Figure 131.)

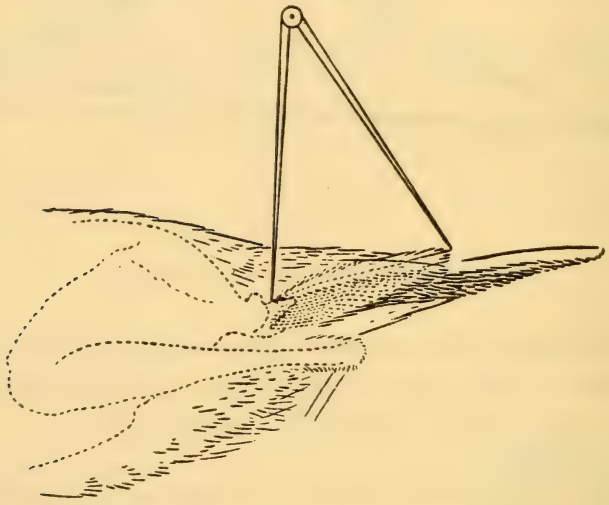

FIGURE 131.—LENGTH OF UPPER TAIL-COVERTS

Distance from upper tail-coverts to end of tail.—This is the distance in a straight line from the tip of the longest upper tail-covert to the end of the tail, measured with dividers when the tail is closed, and will indicate by how much the upper tail-coverts in their natural position fall short of the tip of the tail. (Figure 132.)

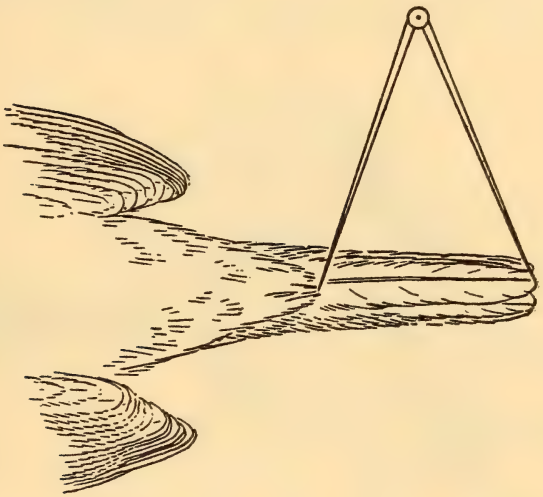

FIGURE 132.—DISTANCE FROM UPPER TAIL-COVERTS TO END OF TAIL

Length of lower tail-coverts.—The length of the longest feather of the lower tail-coverts may be measured in the same manner as that of the upper tail-coverts (see page 102).

Distance from lower tail-coverts to end of tail.—The distance that the longest lower tail-covert falls short of the tip of the tail should be ascertained in the same manner as in the case of the upper tail-coverts (see page 103).

LEG

Length of leg.—The total length of the leg can be measured from the hip joint to the tip of the nail of the longest toe when the leg is straightened as much as possible. It is subject to some error owing to the difficulty of accurately locating the point of measurement in the hip joint; and, of course, can not be taken from a prepared skin. Dividers may be used for a small bird, a ruler for one too large for these. (Figure 133.)

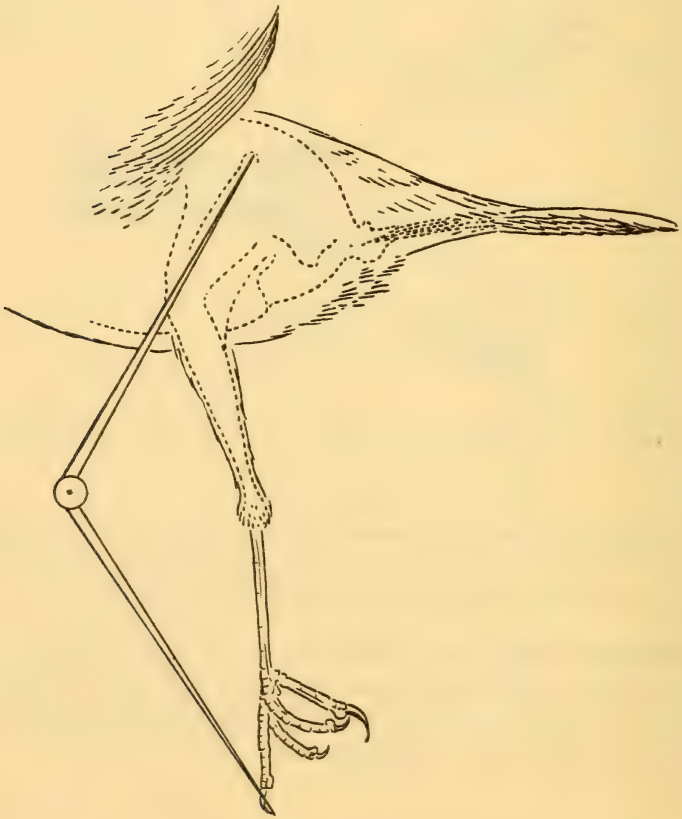

FIGURE 133.—LENGTH OF LEG

Length of thigh (femur).—Since this, the upper segment of the leg, is usually covered by the skin of the body, and the hip joint difficult to define, its length can not be accurately ascertained in the flesh. To take this measurement, the bird is best placed on its side; then, by raising the wing, this part of the leg may be seen through the skin or located by manipulation of the leg under the skin; and one point of the dividers is placed where the thigh joins the body, with the other at the middle of the joint with the tibia. (Figure 134.)

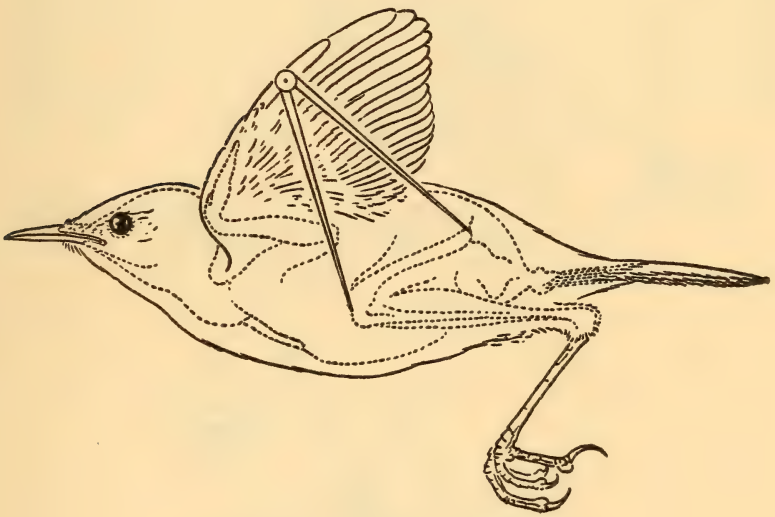

FIGURE 134.—LENGTH OF THIGH

Length of tibia.—The length of the tibia, the second segment of the leg, or 'drumstick,' is ascertained with dividers, but care should be taken in manipulating the joints so that the tips of the dividers measure the greatest length of the tibia from its junction with the femur to its junction with the metatarsus. (Figure 135.)

FIGURE 135.—LENGTH OF TIBIA

Length of tarsus (tarso-metatarsus).—* The length of the 'tarsus' is measured from the exact middle point of the joint between the tibia and metatarsus *behind*, to the lower edge of the lowest undivided scute on the *front* of the junction of the metatarsus with the base of the middle toe, or to the middle of this articulation when such is discernible. This measurement is therefore the diagonal of the tarsus. (Figure 136.)

Some authors measure the tarsus wholly on the *anterior* side, but this method is not so satisfactory, owing to the difficulty of determining the proper point for insertion of the dividers at the upper (anterior) end of the tarsus. In measuring wholly on the posterior side, it is difficult to determine the proper point at the lower end of the tarsus.

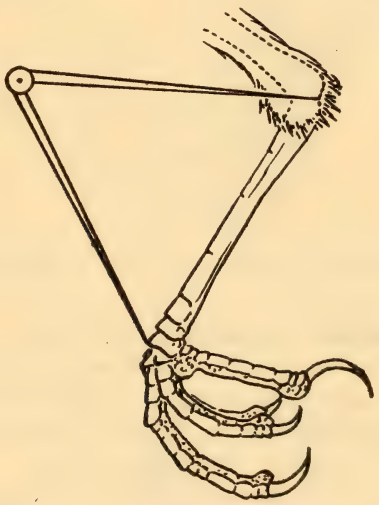

FIGURE 136.—LENGTH OF TARSUS

Length of tarsus and middle toe with claw.—A measurement of the combined length of tarsus and middle toe with claw has been used, and may be taken from the upper end of the tarsus in a straight line to the tip of the claw of the middle toe; but this is easily obtainable by adding the length of the tarsus to that of the middle toe and claw.

Diameter of middle of tarsus.—This measurement is the antero-posterior diameter of the tarsus at the middle point. It is to be taken with dividers at right angles to the longitudinal axis of the tarsus. (Figure 137.)

FIGURE 137.—DIAMETER OF MIDDLE OF TARSUS

Greatest diameter of tarsus.—The greatest measurement of diameter of the tarsus is sometimes useful, and should be taken at the thickest part of the tarsus. A statement should always make clear the particular part of the tarsus measured, and whether taken from front to back or from side to side.

The diameter of other limbs might be useful in special biological or anatomical studies, and can be taken in the same manner as the diameters of the tarsus.

Length of bare portion of leg.—When the tarsus is but partly feathered, or the tibia partly bare, the length of this bare portion of the leg should be measured on the anterior side, from the lower end of the tarsus up to the insertion of the first (lowest) feathers, or to a point opposite these feathers if they happen to be on any other side of the tarsus, even if at this point the leg is but sparingly feathered. (Figure 138.) The length of a bare tibia may be measured alone by beginning at the middle of the ankle-joint.

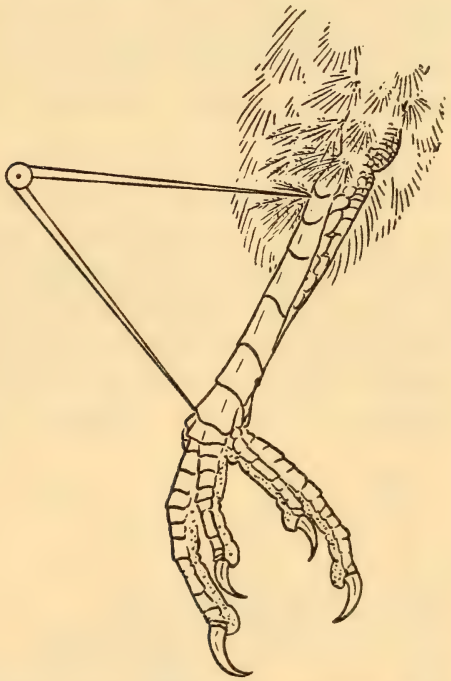

FIGURE 138.—LENGTH OF BARE PORTION OF LEG

Length of tarsal spur.—The chord of the tarsal spur, seen in turkeys (Meleagrididae) and other gallinaceous birds (Galliformes), should be measured in the same manner as the chord of the wing spur (see page 92), in a straight line, with dividers, from the base to the apex.

FOOT

Birds for the most part have three toes in front and one behind, in which case the middle toe is the middle front toe. Most birds which have only two toes in front have two behind, like the cuckoos (Cuculidae) and most woodpeckers (Piciformes), and the middle (third) toe is then really the outer front toe, since it is usually the outer front toe that is rotated backward to occupy a position adjacent to the original posterior toe, where it thus becomes the outer posterior toe; while the original posterior toe becomes the inner posterior toe.

Measurements of all the toes and all the claws are sometimes taken, but those of the middle toe and hind toe are most useful. In all cases the measurement of the length of the claw is the chord of the claw. Care should be taken in all measurements of the toes to make sure that the toe is straight, as otherwise the results will be in error.

Length of middle toe.—The length of the middle (third) toe is measured on its dorsal surface, with dividers, from its very base at the middle of the metatarsal joint, where this is discernible, otherwise from the lower edge of the lowest entire tarsal scute, to its distal end where its integument ends on the base of the claw, and exclusive of the claw. (Figure 139.)

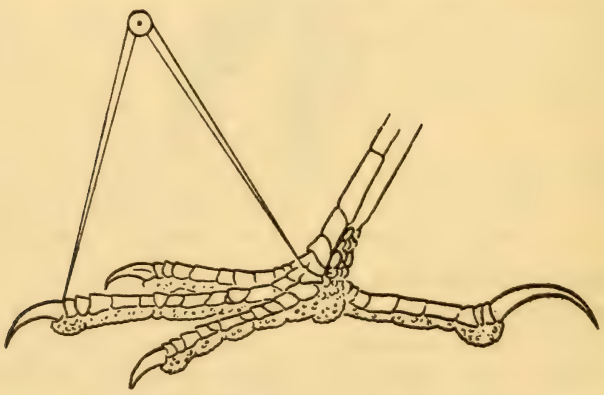

FIGURE 139.—LENGTH OF MIDDLE TOE

Length of middle claw.—The length of the claw of the middle toe, if taken separately, is measured from the point on its upper surface where the skin of the toe impinges on the base of the claw, in a straight line to the tip. This is, therefore, the chord of the claw. (Figure 140.)

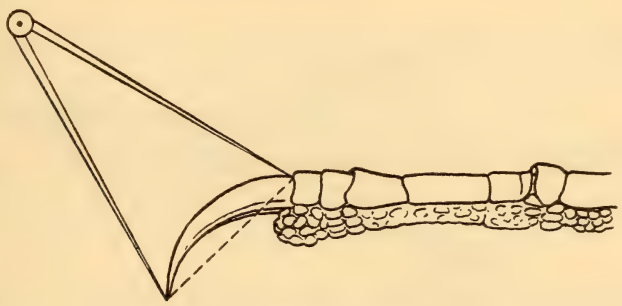

FIGURE 140.—LENGTH OF MIDDLE CLAW

Length of middle toe and claw.—The middle toe together with the claw may be measured with dividers, from the base of the toe on its upper surface in a straight line to the tip of the claw. (Figure 141.)

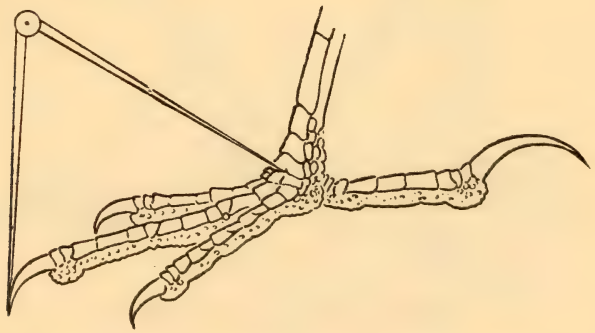

FIGURE 141.—LENGTH OF MIDDLE TOE AND CLAW

Width of middle toe.—The width of the middle toe is measured at the widest part of the toe, whether on upper or lower surface, and is inclusive of the sole. (Figure 142.) When there is much difference between the upper part of the toe and the sole, it is sometimes desirable to measure also the width of the toe without the sole for comparison with the total width.

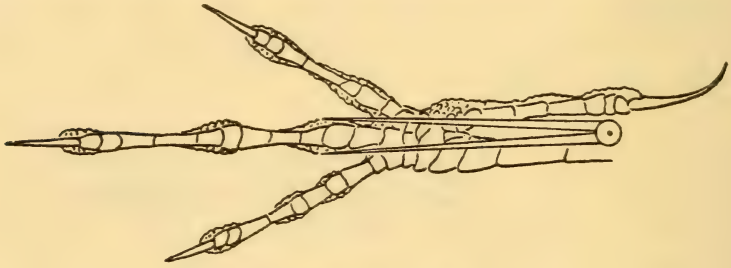

FIGURE 142.—WIDTH OF MIDDLE TOE

Length of outer toe.—The outer (fourth) toe is usually the outer front toe, but, as explained above, it sometimes is the outer hind toe in birds which have only two toes in front. This is measured on its dorsal surface in the same way as the middle toe (see page 110). (Figure 143.)

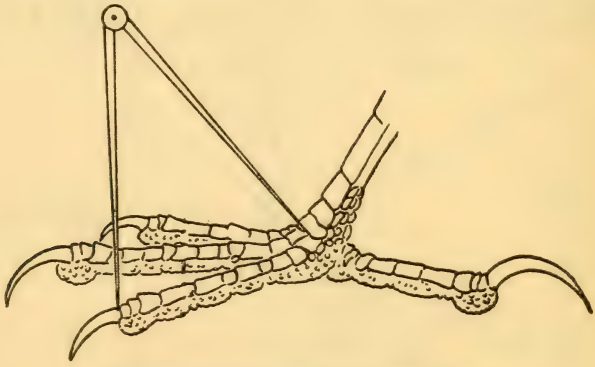

FIGURE 143.—LENGTH OF OUTER TOE

Length of outer claw.—The length of the claw of the outer toe can be measured separately, in the same manner as the claw of the middle toe (see page 111).

Width of outer toe.—The width of the outer toe is measured as is the width of the middle toe (see page 112).

Length of outer toe and claw.—The length of the outer toe and claw is ascertainable as explained under middle toe and claw (see page 111).

Length of inner toe.—The inner (second) toe is nearly always the inner front toe, and its length is measured in the same way as that of the middle or outer toe (see pages 110 and 112).

Length of inner claw.—The length of the claw of the inner toe is measured separately, or included with the toe as are the claws of the middle and outer toes (see pages 111 and 112).

Width of inner toe.—The width of the inner toe is taken at its widest point in the same manner as is the corresponding measurement of the other toes (see pages 112 and 113).

Length of foot.—The length of the whole foot is measured with dividers in a straight line from the tip of the middle claw to the tip of the hind claw, when both middle toe and hallux are fully extended. It can not successfully be taken from a dry skin unless the toes be relaxed; but can, of course, easily be ascertained from a bird in the flesh.

Length of hind toe (hallux).—In birds, such as sparrows (Fringillidae), that have three toes in front, there is only one behind; but in birds that have only two toes in front, there are usually also two behind, and in such cases the real hind (first) toe is (except in trogons [Trogonidae]) the inner posterior toe. This is measured with dividers on the upper side, from the point where the upper edge joins the metatarsus, to the proximal end of the claw. (Figure 144.)

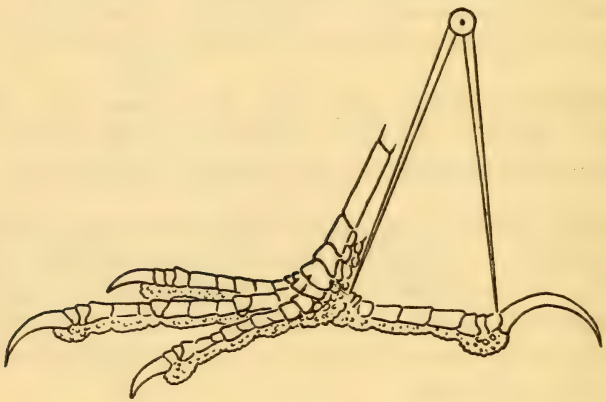

FIGURE 144.—LENGTH OF HIND TOE

Length of claw of hind toe.—The length of the claw of the hallux is measured separately or with the toe, and as are the claws of the other toes (see pages 111–112 and 113).

Width of hind toe.—The width of the hallux is measured in the same manner as the width of the other toes (see pages 112 and 113).

Elevation of hind toe.—When the hind toe is elevated above the position of the others, as in gallinaceous birds (Galliformes), its distance above them may be measured by inserting one point of the dividers at the lower part of the base (sole) of the hind toe where it joins the tarsus, and the other point at the basal end of the lower surface (sole) of the middle toe. (Figure 145.) If the hind toe be webbed or lobed the lobe should be disregarded and measurement made from the base of the toe itself as in other cases.

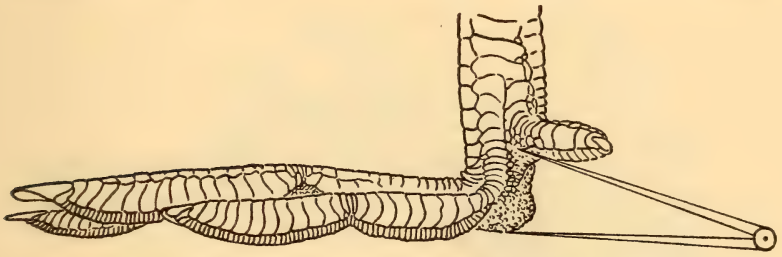

FIGURE 145.—ELEVATION OF HIND TOE

Length of lobe of hind toe.—The length of the lobe of the hind toe, such as is present in grebes (Colymbidae) and many ducks (Anatidae), should be taken with dividers, and is the greatest horizontal length that can be obtained, beginning basally at the point of juncture of the toe with the tarsus. (Figure 146.)

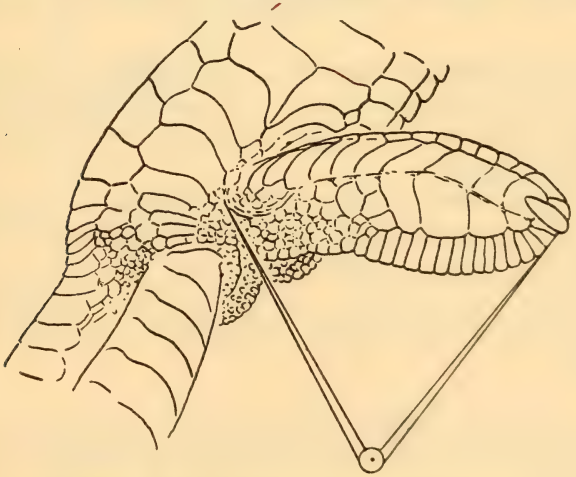

FIGURE 146.—LENGTH OF LOBE OF HIND TOE

Width of lobe of hind toe.—The width of the lobe of the hallux is taken on the upper side, from the outer margin of the sole of this toe to the edge of the lobe, at right angles to the toe, and at the widest part of the lobe. (Figure 147.) In the pied-billed grebe (*Podilymbus podiceps*), from which Figure 147 is drawn, the toe is nearly as wide as the lobe.

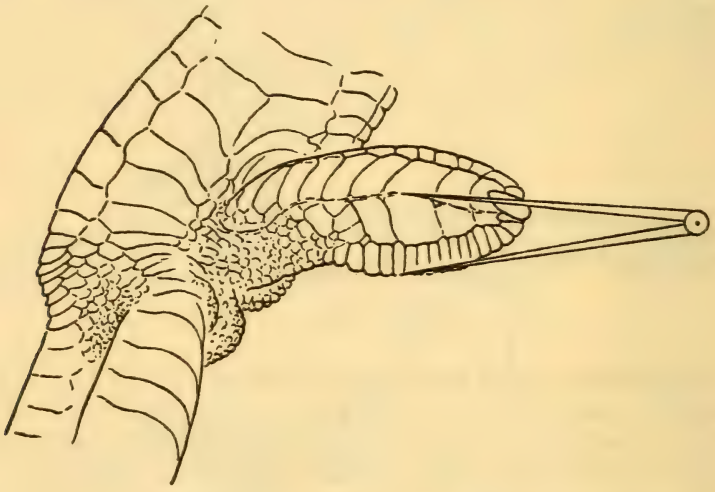

FIGURE 147.—WIDTH OF LOBE OF HIND TOE

Length of lobe of front toe.—The length of a single front toe lobe, such as occurs in grebes (Colymbidae), is measured as is the length of the lobe of the hind toe (see page 115), beginning at the base of the toe itself.

In birds like coots (*Fulica*) in which the lobes of the front toes are more than one, the length of each lobe should be measured at its point of attachment along the toe, from the extreme posterior end to the anterior extremity. At the base of the toe the measurement should begin at the farthest possible posterior point between the toes.

Width of lobe of front toe.—The width of a front toe lobe is measured at the widest part from the outer margin of the sole of the toe, as is the width of the lobe of the hind toe (see page 116).

Greatest length of web between front toes.—The greatest length of each web between the front toes of such birds as gulls (Laridae) and ducks (Anatidae) can be measured with dividers from between the toes at the beginning of the webs at the base of the toes, on the upper surface of the web, to the anterior edge along the middle toe. (Figure 148.)

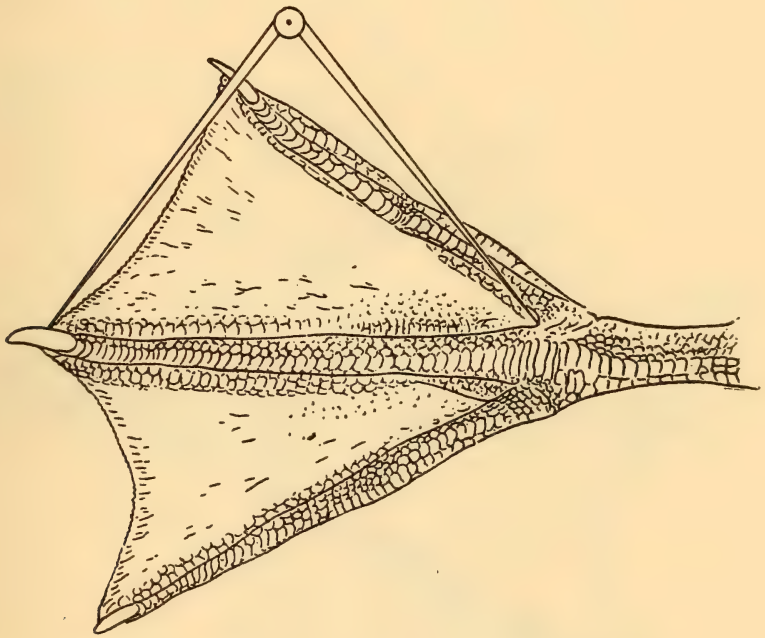

FIGURE 148.—GREATEST LENGTH OF WEB BETWEEN FRONT TOES

Middle length of web between front toes.—The length of each of the webs between the front toes at the middle point of the web is measured from the same posterior point as for the greatest length (see page 117), but to the middle point of the anterior edge of each web. (Figure 149.)

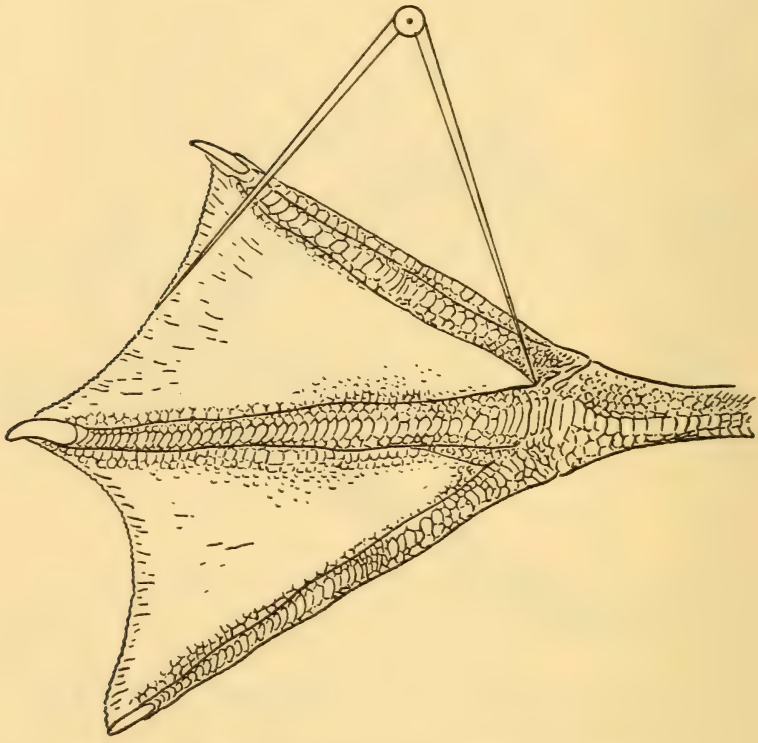

FIGURE 149.—MIDDLE LENGTH OF WEB BETWEEN FRONT TOES

Width of web between front toes.—The width of each web between the front toes should be taken on the upper surface from the anterior point of the web on one toe in a straight line to the same point on the next toe, but not including the toes. (Figure 150.)

This measurement should be made when the foot is fully extended, and can not satisfactorily be taken from a dried skin.

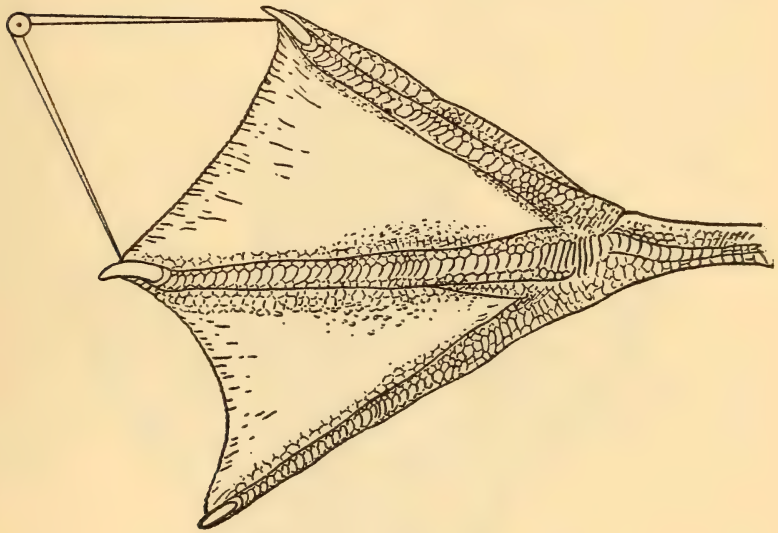

FIGURE 150.—WIDTH OF WEB BETWEEN FRONT TOES

Area of foot.—The area of the foot surface with which swimming birds stroke the water is of importance to the bird in locomotion. To ascertain this, trace on graph paper the outline of the whole foot when fully extended, excluding the hind toe (Figure 151), except in birds like pelicans (Pelecanidae) and their allies (other Pelecaniformes), in which the hind toe is connected by a web with the other toes. From this the area can be determined by means of a planimeter or by counting of squares as explained under area of wing (see page 82). Figure 151 is drawn from a pied-billed grebe (*Podilymbus podiceps*).

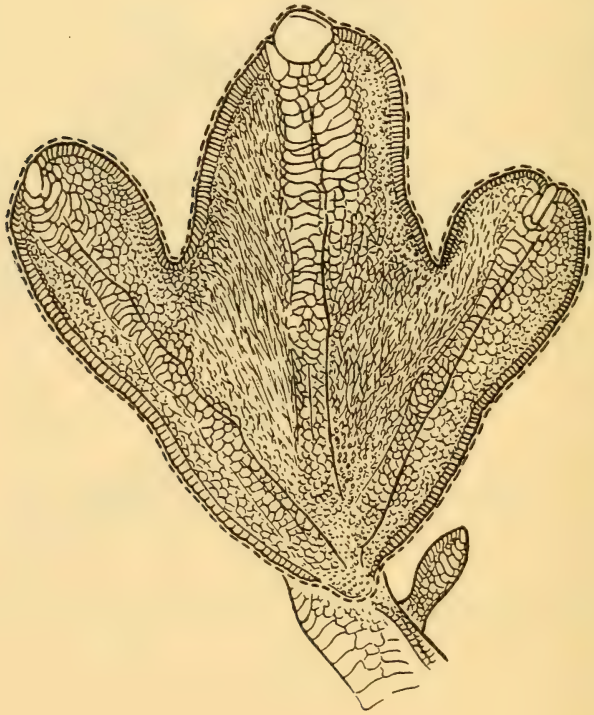

FIGURE 151.—AREA OF FOOT

BIBLIOGRAPHY

The following bibliography includes such publications as contain some separate explanation of the methods of taking measurements of birds. Articles that give only the measurements themselves, even though the statement in connection with the figures often in a way constitutes explanation, are omitted. Furthermore, it has not been considered worth while to include all the editions of books in which the matter pertaining to measurements is simply reprinted without change or addition. The list of titles is doubtless not complete, but will be found to comprise probably all the important publications. In these references only the pages containing the measurement data are cited.

A digest of the measurements treated in each publication is added, as of interest in comparison with the method detailed in our own present paper on the subject.

Allen, Joel Asaph.

1889. **Remarks on Individual and Seasonal Variation in a Large Series of Elainea from Chapada, Matto Grosso, Brazil, with a Revision of the Species of the Restricted Genus Elainea.** Bulletin of the American Museum of Natural History, Vol. II, No. 3, Article XVIII, Oct. 31, 1889, p. 188.

Measurements explained are: *length of wing,* taken with dividers without straightening the feathers; *length of tail,* from the insertion point of the middle rectrices to the tip of the longest; the chord of the *exposed culmen;* and the *width of bill at the nostrils.*

Arrigoni Degli Oddi, Ettore.

1902. Remarks on Audouin's Gull (Larus audouini). The Ibis, 8th Series, Vol. II, No. 7, July, 1902, p. 497.

Concerning the measurement of the *bill* this author states that "I always measure the bill from the feathered space down the forehead to the tip."

1904. Manuale di Ornitologia Italiana, p. 13.

The only measurement explained is *total length*, taken from the tip of the bill to the end of the tail.

1929. Ornitologia Italiana, pp. XI–XII.

Illustrations are given of the method of taking the following measurements: *length of wing*, on a ruler with the primaries straightened; *length of tail*, from the point of insertion of middle pair of feathers to tip of longest (with dividers); chord of *exposed culmen;* chord of *total culmen;* chord of *culmen without cere; length of gonys*, in a straight line from gonydeal angle to tip of mandible; and *length of tarsus*, from middle of ankle joint behind to base of middle toe on upper (anterior) surface.

Bahr, Philip Heinrich.

1912. On a Journey to the Fiji Islands, with Notes on the Present Status of their Avifauna, Made during a Year's Stay in the Group, 1910–1911. The Ibis, 9th Series; Vol. VI, No. 2, April, 1912, p. 293.

"All measurements of *bills* are taken from the anterior part of the nasal aperture to the tip of the bill."

Bailey, Florence Merriam.

1902. Handbook of Birds of the Western United States, pp. XXVII–XXVIII, 2 figs.

The method of taking the following measurements is described: *total length*, as usual; *length of wing*, "from the front of the bend of the wrist joint of the wing to the tip of the longest feather, * * * taken with either tape or dividers"; *length of tail*, from insertion point of middle feathers to tip of longest; *length of bill*, the chord of exposed culmen; *length of tarsus*, "from heel joint to angle of toe with tarsus," in front; and *length of middle toe without claw*, "from angle of tarsus and toes to base of claw."

1921. Handbook of Birds of the Western United States, Revised Edition, pp. XXVII–XXVIII, 2 figs.

Measurements are described exactly as in previous editions.

1928. Birds of New Mexico, November 15, 1928, p. 72, 2 figs.

Methods are indicated (by figures without text) for only *length of tarsus* and of *exposed culmen*, and are the same as those in the author's 'Handbook of Birds of the Western United States.'

Baker, Edward Charles Stuart.

1922. The Fauna of British India, Birds, Vol. I, August 16, 1922, p. 6.

Measurements explained are: *total length*, from tip of bill to tip of tail; *length of closed wing*, with primaries flattened; *length of tail*, from root, "generally indicated both in the fresh and dried state by the presence of a piece of flesh on the underside, to the tip of the longest feather"; *length of tarsus*, "from the center of articulation of the tarsus with the tibia to the base of the middle toe"; and the chord of *exposed culmen*.

Bannerman, David Armitage.

1912. On a Collection of Birds Made by Mr. Willoughby P. Lowe on the West Coast of Africa and Outlying Islands; with Field Notes by the Collector. The Ibis, 9th Series, Vol. VI, No. 2, April, 1912, p. 245.

"The measurement of the *tail* is taken from between the base of the middle tail-feathers to the tip."

1930. The Birds of Tropical West Africa, p. lxii.

The following paragraphs of explanation are taken verbatim from this work:

"*Total length* (in the flesh).—A straight line taken from the tip of the bill to the tip of the longest tail feather when the bird is laid on its back without any undue stretching, the bill parallel with the line of the body. This measurement is of no value if taken after the specimen has been skinned.

"(A useful measurement taken *in the flesh* is that from the tip of the wing to the tip of the tail, particularly if it is intended to figure the bird or to mount it.)

"*Expanse.*—The distance between the tip of the longest primary in each wing, when the wings are stretched out to their utmost.

"*Bill.*—The usual method of taking this measurement is with dividers in a straight line from the base of the feathers on the forehead to the tip (never over an arched culmen). When this method is impracticable a measurement may be taken from the rear of the nasal aperture to the tip, or again from the gape to the tip; this last is not

to be recommended unless the first two fail. In diurnal Birds of Prey and Parrots the bill is measured from the edge of the cere to the tip.

"*Wing.*—From the bend or carpal joint to the tip of the longest primary, the wing placed on a steel or wooden rule and pressed flat against it, thus obtaining the longest measurement. In very large birds a steel tape has been used, the measurement taken from the carpal joint with the wing pressed on a table and the tape stretched along the *under* side of the wing, not over the curve.

"*Tail.*—Measured by inserting one point of the dividers between the central pair of tail feathers and pressing it as far as it will go towards the base, the other point of the dividers at the tip of longest tail feather as it lies naturally; if curly I have not stretched it out to its fullest length.

"*Tarsus.*—Measured from the center of the tibio-tarsal joint, as near as this can be ascertained, to the base of the middle toe where it joins the tarsus.

"*Middle Toe.*—From the base to the tip, including the claw, unless otherwise stated."

Barrows, Walter Bradford.

1912. Michigan Bird Life, pp. 16–17.

The measurements described are *total length; extent of wings; length of closed wing*, without straightening the feathers (chord); *length of exposed culmen* (chord); *length of tail*, from the center of the coccyx; and *length of tarsus*, on the anterior side.

Bates, George Latimer.

1930. Handbook of the Birds of West Africa, p. VI.

Directions for taking the following measurements are given: *length of wing*, from the carpal joint to tip of longest "feather," with the primaries straightened; *length of tail*, from point of insertion of middle feathers to tip of longest; *length of bill*, the exposed culmen, apparently the chord, as it is to be taken with dividers; and *length of tarsus*, "the length of the tarso-metatarsal (shank) bone."

Belcher, Charles Frederic.

1930. The Birds of Nyassaland, p. xii.

The measurements explained are *total length*, from tip of bill to tip of tail; and *length of closed wing*, "from the bend to the tip of the longest feather [sic]."

Bishop, Louis Bennett.

1921. Description of a New Loon. The Auk, Vol. XXXVIII, No. 3, July, 1921, p. 368.

Mentions that his measurements of *wing*, *tail*, *exposed culmen*, *depth of bill at base*, *tarsus*, and *outer toe with nail* are "taken with dividers except the wing, which was taken with a steel tape following the natural contour."

Bowen, Wilfrid Wedgwood.

1926. Catalogue of Sudan Birds. Publication No. 1, Sudan Government Museum (Natural History), May, 1926, pl. I.

No explanation is given of the plate, which apparently is intended to illustrate the manner of taking measurements of the *length of the culmen*, *tarsus*, and *toe*.

Brooks, Allan.

1920. Notes on Some American Ducks. The Auk, Vol. XXXVII, No. 3, July, 1920, p. 358.

Description is given of measurement of the *height of the maxilla* from the base of the exposed culmen to the nearest point on the cutting edge of the maxilla (i. e., the chord of the distance around the curve of the bill); and also the vertical height at the same place.

Buchner, Otto.

1931. Specht-Naumann Die Vögel Europas, Band I, Lieferumg 1, p. 29.

The measurements explained are: *total length*, as usual; *extent of wings*, as commonly taken; *length of wing*, from bend to tip; *length of tail*, from insertion of the middle pair of rectrices to the tip of the longest; *length of bill*, from the base of the exposed culmen to the tip; and *length of tarsus*, "vom Fersengelenk bis zum Austritt der Hinterzehe."

Burgess, Lieutenant.

1854. Note on the Indian Weaver-Bird (Ploceus philippensis). Proceedings of the Zoological Society of London, Vol. XX, for 1852, May 23, 1854, p. 88.

The *length of the wing* is measured "from the carpal joint to the end of the longest quill-feather."

Chapin, James Paul.

1924. Size-variation in Pyrenestes, a Genus of Weaver-Finches. Bulletin of the American Museum of Natural History, Vol. XLIX, Article IV, September 3, 1924, p. 418, fig. 2.

The method of taking two measurements of the bill is illustrated: *length of bill from nostril*, the chord of this distance; and *width of mandible*, the distance across the chin between the outside edges of the posterior ends of the exposed portion of the rami.

Chapman, Frank Michler.

1895. Handbook of Birds of Eastern North America, p. 37.

The measurements described are: *total length*, taken in the usual manner; *length of wing*, "from the 'bend of the wing' to the end of the longest primary"; *length of tail*, from insertion of middle feathers to tip of longest; chord of *culmen*, "from the anterior base of the feathers on the forehead to the tip of the upper mandible"; *length of tarsus*, "from the base or insertion of the toes, to the end of the tibia."

1912. Handbook of Birds of Eastern North America, Revised Edition, pp. XVII–XVIII.

Measurements are taken in exactly the same way as in the 1895 edition of the same book.

Cory, Charles Barney.

1880. Birds of the Bahama Islands, p. 39.

Measurements described are: *total length*, taken in the usual manner; *length of wing*, without straightening the primaries; *length of tail*, "distance from the body to the end of the longest feather"; *length of bill* (chord), "from the tip to where it joins skin or feathers on the forehead"; *length of tarsus*, "distance in front from the knee-joint [sic] to the root of the middle toe."

1890. The Birds of the Bahama Islands, Revised Edition, p. 39.

The description of measurements is exactly the same as in the first edition.

1899. The Birds of Eastern North America, Part 1, pp. 8–9, 2 figs.

Total length is measured in a straight line with dividers from tip of bill to end of longest tail-feather; and also to the end of the outermost feather, when this is much shorter than the middle pair. Other measure-

ments are: chord of *closed wing* (taken without straightening the primaries); *tail*, the distance from the tip of the longest rectrix to the point where this same feather enters the skin; chord of *exposed culmen;* "some curved bills are measured along the *curve of the culmen*"; *bill from nostril to tip;* and *tarsus*, on the anterior face, from the end of the tibia to the root of the middle toe.

1909. The Birds of Illinois and Wisconsin. Zoological Series, Field Museum of Natural History, Vol. IX, pp. 20–21, 2 figs.

Measurements are exactly the same as in this author's 'Birds of Eastern North America.'

Coues, Elliott.

1872. Key to North American Birds [First Edition], pp. 55–57.

The manner of taking the following considerable number of measurements is carefully explained: *total length*, obtained as usual; *extent of wings*, with ruler or tape; *length of closed wing*, without straightening the primaries (the chord); *length of tail*, from middle of coccyx to end of longest tail-feather; chord of *exposed culmen; depth* (=*height*) *of bill*, at base of exposed culmen, taken vertically; *width of bill*, taken transversely at the same point; *bill from gape*, in a straight line to the tip of the maxilla; *length of tarsus*, on anterior side from middle of joint with tibia to middle of articulation with middle toe; *length of toes*, from joint with tarsus to root of claw, on upper surface; chord of *length of claws*, from base to tip; and *length of head*, from base of exposed culmen to the farthest posterior point on the occiput.

1884. Key to North American Birds, Second Edition, pp. 24–25.

Measurements are the same as in the first edition, but height of bill, width of bill, and bill from gape are omitted. All are taken as in the previous edition.

1927. Key to North American Birds, Sixth Edition, Vol. 1, pp. 24–25.

Measurements are the same as in the second edition.

Crabb, Edward Drane.

1930. The Woodpeckers of Oklahoma. Publications of the University of Oklahoma Biological Survey, Vol. II, No. 3, November 10, 1930, pp. 115–116.

The detailed explanations of measurements are reproduced verbatim below.

"The *length* is the distance from the tip of the bill to the end of the longest rectrix, taken as follows: Lay the bird flat on its back on a rule, on the table, then grasp the head with the left forefinger and thumb, placing the ring finger against the end of the bird's bill in such a way that you can, without even looking, hold the tip of the bill even with the end of the rule. This, of course, requires some practice, or else errors will creep into the length measurements of specimens. Now grasp the feet of the bird with the right hand and pull gently, but firmly, holding the tip of the bill at the end of the rule; the tip of the tail will indicate the length of the bird.

"The *extent* is the maximum distance from the tip to tip of the extended wings. The bird must be lying on its back on a flat surface, preferably on a rule. Now grasp the left wing at the carpals with the right hand and gently stretch the bird out. The figure indicated by the longest primary of the left wing is the extent of the bird. If the rule is too short the next best thing to do is to mark the extent of the bird on the table and then measure the distance between the marks. Simple as this seems, few beginners are able to measure the same specimen twice and get even approximately the same results.

"The *wing length* is the greatest distance from the outside of the bend of the wing (carpals) to the tip of the longest primary taken with dividers or on the underside with a rule, as follows: Lay the specimen on its stomach and grasp the wing near the bend (preferably the right wing), with the left hand, placing a finger at the bend so that the end of the rule, when placed under the wing, will just touch the finger. Thus the tip of the longest primary will indicate the wing length. The primaries must not be bent in the least as this will make the wing length appear abnormally great.

"The *tail length* as recorded in this paper is in reality the length of the longest tail feather—from the tip to the end of its root. In small birds, I simply blow the feathers aside so as to expose the oil duct, and then I can easily place the point of the dividers at the root-tips of the rectrices. Place one point of the dividers at the roots of the tail feathers and the other point at the end of the longest feather; then apply the dividers to a rule to get the distance between the points in inches which will be the length of the bird's tail.

"The *bill length* is taken with dividers. I always place one point of the dividers on the merging line of the feathered soft skin and horny covering at the dorso-posterior end of the bill, (which is readily noticeable as a fold of skin) and then place the other point at its tip. I have adhered to this method in my descriptions. Many ornithologists measure only from the point where the ends of the feathers touch the bill, and designate the measurement when taken as I have directed, the exposed culmen [sic].

"The *tarsus* is the length of the tarso-metatarsal ('shin') bone, and is taken with dividers. The toes and tibia ('drum stick') should be bent forward and the points of the dividers placed, from the front side, in

the bends of the toes and heel in such a way as to give the distance between these two joints.

"The *third toe length* is the length of the extended middle toe, not including the nail. I use dividers in taking this measurement, but by placing the corner of the rule in the joint of the middle toe and tarsus, from the bottom side of the foot, one may obtain accurate results in the larger specimens.

"The *third toe and claw length* is taken as is that of the third toe except that the length of the claw is included."

Dwight, Jonathan.

1902. Individual, Seasonal and Geographical Variations of the American Goldfinch (Astragalinus tristis). The Auk, Vol. XIX, No. 2, April, 1902, p. 160.

In this paper the following measurements are explained: *length of closed wing*, taken with dividers from the bend to tip of longest primary; *length of tail*, from the point of insertion of middle pair of feathers to tip of longest; *tarsus*, also *middle toe*, "along their greatest anterior length"; *bill*, "along the chord of the culmen and also its greatest depth."

1919. Reasons for Discarding a Proposed Race of the Glaucous Gull (Larus hyperboreus). The Auk, Vol. XXXVI, No. 2, April, 1919, p. 247, fig. 2.

The illustration shows that the measurement of the *length of the bill* is taken with calipers and is not the chord of the culmen, but the horizontal length; and that the *height of the bill* is taken at the mental apex. No other measurements are described.

1925. The Gulls (Laridae) of the World; Their Plumages, Moults, Variations, Relationships and Distribution. Bulletin of the American Museum of Natural History, Vol. LII, Article III, December 31, 1925, pp. 123–124.

In this paper Dwight states that he measures the chord of the *length of closed wing;* the *length of tail*, from the insertion of the middle rectrix; the chord of *exposed culmen;* the *length of the tarsus*, along the anterior margin; the *middle toe without claw; depth of bill at base* of exposed culmen; and *depth of bill*, vertically at angle of gonys.

Forbush, Edward Howe.

1925. Birds of Massachusetts and Other New England States, Part I, p. XXXI, 3 figs.

The author describes his methods of taking the following several measurements: *total length*, as usual, with the bird on its back along a

ruler; *extent of wings*, as usual; *length of wing*, with a ruler, the primaries straightened, or with a steel tape "along the outer surface"; *length of tail*, with dividers, from the insertion point of the middle pair of rectrices to the tip of the longest; chord of *exposed culmen*, "from its tip to the feathers of the forehead"; and *length of tarsus*, on the anterior side.

Funk, Mrs. A. B.

1931. Methods of Bird Study, p. 5.

Two measurements are figured in this work, but with no explanation in the text. These are the *length of bill*, evidently the exposed culmen; and the *length of tarsus*, measured in front.

Grinnell, Joseph; Bryant, Harold Child; and Storer, Tracy Irwin.

1918. The Game Birds of California, December 28, 1918, p. 66, fig. 4.

The measurements described are: *total length*, taken in the usual manner; *length of closed wing*, without straightening the primaries; chord of *exposed culmen; length of tarsus*, on the anterior side from middle of joint with tibia to middle of joint with middle toe; and *length of middle toe*, "from the angle just below the lower end of the tarsus to the base of the claw," on the upper surface. The illustration of "bill along culmen" indicates that the measurement is the horizontal length of the bill, but the text states that it is the chord of the exposed culmen.

Gross, Alfred Otto.

1928. The Heath Hen. Memoirs of the Boston Society of Natural History, Vol. VI, No. 4, May, 1928, pp. 565-567.

Of the numerous different measurements recorded in this monograph, only the following are explained: "*body-wing*" [*length of open wing*] is the distance from the thorax to the tip of the longest primary of the outstretched wing; "*pinna*" [*length of neck tuft*] is the length of the longest feathers of the "neck-wings"; "*pinnae extent*" [*width of neck tuft*] is the distance from tip to tip of the outstretched pinnae; "*gape*" [*length of bill from gape*] is the distance from angle of mouth to tip of bill; "*width of mouth*" [*width of bill at gape*] is the distance from the angle of the mandibles of one side to the angle of the other side; "*eye-bill*" is the distance from the anterior angle of the eye to the tip of the bill; "*tarsus-toe*" is the distance from the heel to the tip of the nail of the third toe; *tarsus* equals the above measurement minus the length of the third toe; "*body-toe*" is the distance from the abdomen to the tip of the third toe-nail; *web between toes* is the distance "from the angle of the toes to edge of the web"; *length of bill*, "from the base of the frontal bone to the tip of the bill"; and *middle toe with claw*, taken with a flexible steel

tape from the first scutellum on the lower end of the tarsus to the tip of the claw.

1930. Progress Report of the Wisconsin Prairie Chicken Investigation, pp. 94–96.

The following measurements are explained:

"*Length*, distance from tip of bill to tip of longest tail feather or down in the case of downy young where no feathers are yet developed. *Tail*, base of uripigeal [sic] gland to tip of longest tail feather. *Bill*, tip of bill to base of frontal bone of the cranium. *Bill-eye*, tip of bill to the anterior angle of the eye. *Bill-gape*, tip of bill to the angle of the mouth when opened. *Bill-nostril*, tip of bill to the anterior angle of the nostril. *Eye*, distance from the anterior to the posterior angles of the eyelids. *Extent*, distance from tip to tip of outspread wings. *Wing*, distance from bend of wing to tip of longest primary. *Foot-body*, distance from tip of nail of third toe to attachment of femur. *Tarsus-toe*, tip of third toe to the heel. *Foot*, tip of nail of first toe (hind) to tip of nail of third toe (front).

"*Toes* are measured by bending them at right angles to the tarsus and measuring the distance from tip of nail to tarsus by means of a pair of calipers. The *nails* are measured by taking the shortest distance from the tip of the claw to the first scale on the dorsal surface of the toe."

Gurney, John Henry.

1882. Notes on a 'Catalogue of the Accipitres in the British Museum' by R. Bowdler Sharpe (1874), The Ibis, 4th Series, Vol. VI, No. 22, April, 1882, p. 311, footnote; No. 23, July, 1882, p. 438 and footnote.

Describes the measurement of *wing length*, which he takes with a flexible measure around the curve of the wing from the carpal joint to the tip of the longest primary. Mentions also (p. 438, footnote) that when the two wings of a bird vary in length he uses the longer one.

1902. On Anser erythropus and Its Allies. The Ibis, 8th Series, Vol. II, No. 6, April, 1902, p. 274.

The author says of his measurement of the *culmen* that it was "taken from the tip of the beak to the commencement of the frontal feathers."

Hartert, Ernst [Johann Otto].

1903. Die Vögel der paläarktischen Fauna, Band I, Heft 1, November, 1903, p. XII.

Measurements explained are: *length of wing*, from bend of wing to tip, with the primaries straightened; *length of tail*, from insertion of

middle feathers to tip of longest; chord of *length of exposed culmen; length of total culmen;* and *length of tarsus*, from the middle of the joint with the tibia behind, to the lowest scute in front.

Kennard, Frederic Hedge.

1927. The Specific Status of the Greater Snow Goose. Proceedings of the New England Zoölogical Club, Vol. IX, February 16, 1927, p. 88.

In this paper the measurement of the *length of bill* is the chord of exposed culmen; and the *height of bill* is the vertical measurement "at junction of forehead and culmen."

Kloss, Cecil Boden.

1918. On Birds Recently Collected in Siam, Part I, Phasianidae—Eurylaemidae. The Ibis, 10th Series, Vol. VI, No. 1, January 22, 1918, p. 103.

This author discusses the relative advantages of measuring the *bill from the gape*, as compared with the measurement from the nostril.

Loomis, Leverett Mills.

1888. On the Further Occurrence of Otocoris alpestris praticola in Chester County, South Carolina. The Auk, Vol. V, No. 2, April, 1888, p. 207.

The only measurements explained are the *length of wing*, which is the chord (i. e., with the primaries not straightened); and the *length of tail*, which is "the actual length of the longest rectrix."

1918. A Review of the Albatrosses, Petrels, and Diving Petrels. Proceedings of the California Academy of Sciences, 4th Series, Vol. II, Part II, No. 12, April 22, 1918, pp. 70–71.

The method of taking certain measurements is described as follows:

"In measuring the *wing* from the carpal joint to the tip of the longest primary, the primaries were flattened against the surface of the rule. The *length of the culmen* is the chord of the exposed culmen, and was taken with dividers. The *depth of the upper mandible* is the distance between the base of the exposed culmen and a point directly below it on the tomium; and the *width of the upper mandible* is the diameter at the base of the exposed sides of the mandible; the former dimension being taken with dividers and the latter with a 15 cm. caliper square. The *length of the tail* is approximate, and was obtained by inserting one point of the dividers into the base of the tail between the two middle rectrices and extending the other point to the end of the longest rectrix."

Lynes, Hubert.

1930. Review of the Genus Cisticola. The Ibis, 12th Series, Vol. VI, Supplementary Number, December, 1930, p. 66, pls. I–XIX.

From the text and the figures on the plates it may be inferred that the author of this monograph measures the "*leg*" (=tarsus) in front from its upper end to the last scutes on the lower extremity; and the *middle toe and claw* from the latter point to the tip of the claw (the horizontal length).

Martorelli, Giacinto.

1895. Monografia Illustrata degli Uccelli di Rapina, pp. 10–11.

This Italian investigator measures the *total length*, as usual; the *length of wing*, with a tape around the curve; *length of tail*, to end of the longest feather; *length of bill to gape; length of tarsus*, from middle of articulation with tibia to articulation with middle toe; and *length of middle toe*, from point of articulation with tarsus to base of claw.

Minot, Henry Davis.

1877. The Land-Birds and Game-Birds of New England, p.21.

Measurements explained are: *total length*, taken as usual; chord of *exposed culmen; depth of bill*, taken vertically "near the base"; and the *length of tarsus*, taken in front.

1895. The Land-Birds and Game-Birds of New England, Second Edition, p. 19.

Measurements are just the same as in the first edition.

Monchaux, Delamarre De.

1923. Encyclopédie Pratique du Naturaliste, Part IX, Les Oiseaux Chanteurs, p. XLIX, pl. XVII (p. LV).

Only *total length* and *extent of wings* are explained, to be taken in the usual manner.

Murphy, Robert Cushman; and Harper, Francis.

1921. A Review of the Diving Petrels. Bulletin of the American Museum of Natural History, Vol. XLIV, Article XVII, December 23, 1921, p. 505.

The only measurement explained is *depth of bill*, "taken just in front of the nasal eminences."

Oates, Eugene William.

1889. The Fauna of British India, including Ceylon and Burma, Birds, Vol. I, p. XII.

The following measurements are described: *total length*, taken as usual; *length of wing*, from the bend of the wing to the tip of the longest primary, with the feathers straightened; *length of tail*, "the distance from the root of the tail * * * to the tip of the longest feather"; *length of tarsus*, "the distance from the centre of articulation of the tarsus with the tibia to the base of the middle toe"; and *length of bill from gape*, the chord of the distance from the gape to the tip of the bill.

Oberholser, Harry Church.

1905. The Avian Genus Bleda Bonaparte and Some of Its Allies. Smithsonian Miscellaneous Collections, Quarterly Issue, Vol. XLVIII, Part II, July 1, 1905. pp. 149–150.

Measurements are described as follows: *length of wing*, the distance from the bend of the wing to the tip of longest primary, taken with dividers without straightening the quills; *length of tail*, the distance from the coccygeal insertion of the middle feathers to the tip of the longest rectrix; *length of exposed culmen*, the chord of the culmen, taken from its tip to the point where the feathers of the forehead impinge on its base; and *length of tarsus*, measured from the center of the ankle joint behind to the edge of the last tarsal scute in front.

1912. A Revision of the Subspecies of the Green Heron (Butorides virescens Linnaeus). Proceedings of the United States National Museum, Vol. XLII, August 29, 1912, p. 533.

The measurements described in this paper are as follows: *length of wing*, measured in a straight line from the bend of the closed wing to the end of the longest primary with these feathers in their natural position, that is, not straightened; *length of tail*, taken with dividers from the point of insertion of the middle rectrices to the tip of the longest; *length of exposed culmen*, measured in a straight line from the beginning of the feathers on the culmen to the tip of the maxilla, that is, the chord of the exposed culmen; *height of bill*, the distance in a straight line from the base of the exposed culmen to the nearest point on the ramus of the mandible; *length of tarsus*, a straight line from the center of the ankle joint on the posterior side to the middle of the joint between the metatarsus and the middle toe on the anterior side; *length of middle toe*, measured along the upper side from the middle of the joint between the metatarsus and the middle toe to the base of the uncovered claw.

1914. A Monograph of the Genus Chordeiles Swainson, Type of a New Family of Goatsuckers. Bulletin of the United States National Museum, No. 86, April 6, 1914, p. 2.

Measurements explained are: *length of wing*, measured in a straight line from the bend of the closed wing to the end of the longest primary, with the primaries in their natural position, that is, not straightened; *length of tail*, taken with dividers from the point of insertion of the middle rectrices to the tip of the longest; *length of exposed culmen*, measured in a straight line from the beginning of the feathers on the culmen to the tip of the maxilla,—that is, the chord of the exposed culmen; *length of tarsus*, a straight line from the center of the heel joint on the posterior side to the middle of the joint between the metatarsus and the middle toe on the anterior side; *length of middle toe*, measured along the upper side, from the middle of the joint between the metatarsus and the middle toe, to the base of the uncovered claw.

1918. A Review of the Plover Genus Ochthodromus Reichenbach and Its Nearest Allies. Transactions of the Wisconsin Academy of Sciences, Arts, and Letters, Vol. XIX, Part I, December 30, 1918, pp. 513–514.

The measurements explained are: *length of wing*, the distance from the bend of the wing to the tip of the longest primary, taken with dividers without straightening the quills; *length of tail*, the distance from the coccygeal insertion of the middle feathers to the tip of the longest rectrix; *length of head*, the distance from the point where the feathers of the forehead end on the culmen, to the hindmost point of the skull, taken in a straight line with dividers; *length of exposed culmen* (length of bill), the chord of the culmen, taken from its tip to the point where the feathers of the forehead impinge on its base; *height of bill at base*, the distance in a straight line from the base of the exposed culmen to the nearest point on the ramus of the mandible; *width of bill at loral feathering*, measured with dividers at the point on the side of the bill where the loral feathering ends; *length of dertrum*, measured in a straight line from the posterior end of the dertrum to its tip; *length of tarsus*, a straight line from the center of the heel joint on the posterior side to the middle of the joint between the metatarsus and the middle toe on the anterior side; *length of middle toe without claw*, measured along the upper side from the middle of the joint between the metatarsus and the middle toe to the base of the uncovered portion of the claw; *length of middle toe with claw*, measured with dividers along the upper side from the middle of the joint between the metatarsus and the middle toe, in a straight line to the tip of the claw.

1919. The Geographic Races of Hedymeles melanocephalus Swainson. The Auk, Vol. XXXVI, No. 3, July, 1919, p. 409.

Explanation is made of the measurement of the *height of bill* used by Mr. Ridgway in Volume I of his 'Birds of North and Middle America,' where this dimension is taken from the base of the exposed culmen to the malar angle, instead of to the ramus of the mandible directly below.

1919. The Status of Larus hyperboreus barrovianus Ridgway. Proceedings of the Biological Society of Washington, Vol. XXXII, September 30, 1919, pp. 174–175.

In this paper attention is called to the difference in results obtained from measuring the *horizontal length of the bill* and the chord of the *exposed culmen.*

1921. The Anatine Genus Nyroca and Its Nearest Allies. Proceedings of the Indiana Academy of Science, for 1920, October 1, 1921, p. 106.

Measurements explained are: *length of wing*, the distance from the bend of the wing to the tip of the longest primary, taken with dividers without straightening the quills; *exposed culmen* (*length of bill*), the chord of the culmen, taken from its tip to the point where the feathers of the forehead impinge on its base; *height of bill at extreme base*, the distance in a straight line from the highest point on the base of the maxilla to the nearest point on the ramus of the mandible; *width of bill*, measured with dividers at the widest point near the end of the bill; also at base; at point of greatest width; and at the posterior end of the nail where this coalesces with the culmen; *length of the nail of bill*, the chord of the dertrum, measured in a straight line from its tip to the point where it coalesces with the culmen; *length of inner toe with claw*, measured with dividers along the upper side from the middle of the point between the metatarsus and the inner toe, in a straight line to the tip of the claw.

1923. A Review of the Genus Prionochilus Strickland and Its Closest Allies. Ohio Journal of Science, Vol. XXIII, No. 6, December 21, 1923, pp. 287–294.

The following explanation is given of measurements: "*length of wing*, measured in a straight line from the bend of the closed wing to the end of the longest primary, with the primaries in their natural position,—that is, not straightened; *exposed culmen* (length of bill), measured in a straight line from the beginning of the feathers on the culmen to the tip of the maxilla,—that is, the chord of the exposed culmen; *width*

of bill at base, taken with dividers at the beginning of the feathers on the culmen: *length of tarsus*, a straight line from the center of the ankle joint on the posterior side to the middle of the joint between the metatarsus and the middle toe on the anterior side."

Paris, Paul.

1921. Faune de France, 2, Oiseaux, pp. 38–39.

Measurements described are as follows: *total length*, as usual; *extent of wings*, the ordinary dimension; *length of wing*, "prise de sa courbure au bout de la plus longue remige"; *length of tail*, from the root of the middle retrices to the tip of the longest; *length of bill*, the chord of *exposed culmen; length of tarsus*, from the tibio-tarsal articulation behind to the articulation with the middle toe in front; *length of middle toe*, "depuis son articulation avec le tarse à son extrémité, sans l'ongle (doight nu) ou avec l'ongle (doight armé)."

Pearson, Thomas Gilbert; Brimley, Clement Samuel; and Brimley, Herbert Hutchinson.

1919. Birds of North Carolina, p. 14.

The only measurements explained are: *total length*, taken in the usual manner; and *length of wing*, "from the last bend of the wing to the tip of the longest wing-feather."

Phillips, E. Lort.

1898. Narrative of a Visit to Somaliland in 1897, with Field-notes on the Birds Obtained during the Expedition. The Ibis, 7th Series, Vol. IV, No. 15, July, 1898, p. 407.

Measurement of the *length of tail* is described as of "the actual feathers measured from the base to the tip," not including the root of the tail.

Prjevalsky, Nicolas Michaelovich.

1887. On New Species of Central-Asian Birds. The Ibis, 5th Series, Vol. V, No. 20, October, 1887, p. 402, footnote.

Total length is said to be taken "from the point of the bill to the end of the tail."

Ramsay, Robert George Wardlaw.

1923. Guide to the Birds of Europe and North Africa, p. vi.

Length of bill used in this work is the horizontal length "from the level of the end of the frontal feathers in a straight line to the tip of the bill."

Reichenberger, Elsie M. B.

1923. Remarks on Methods in Measuring Birds. The Auk, Vol. XL, No. 2, April, 1923, pp. 244–247.

Discusses "American" and "European" methods, and suggests that the method of measuring *wing length* by straightening the primaries, and the method of measuring *tail length* from the insertion of the middle feathers to the tip of the longest be universally adopted.

Reichenow, Anton.

1905. Benennung der äusseren Teile des Vogelkörpers und Messungen. Ornithologische Monatsberichte, Vol. XIII, No. 3, March, 1905, p. 47.

Reichenow here describes measurements of *total length*, taken in the ordinary manner; *length of wing*, with primaries straightened; *length of tail*, from the beginning of the insertion of the lower tail-coverts to end of longest rectrix; chord of *exposed culmen;* chord of *culmen without cere; length of tarsus*, from upper end behind to lower end in front; chord of *length of middle toe and claw*, beginning on upper surface; and chord of *middle claw*. All of these except wing and tail are taken in the same manner as we suggest in the present paper. Six of them are illustrated.

1910. Die Vögel Afrikas, Band I, erste Hälfte, p. 3.

Measurements here described are exactly the same as those indicated in the same author's paper in the Ornithologische Monatsberichte, 1905, p. 47, above cited, with the addition of *extent of wings*, taken in the usual manner.

1913. Die Vögel; Handbuch der Systematischen Ornithologie, Vol. I, pp. 64–66, figs. 59–64.

Measurements used here are taken in identically the same way as those of the author's paper in the Ornithologische Monatsberichte for 1905, p. 47.

Rhoads, Samuel Nicholson.

1893. The Vireo huttoni Group, with Description of a New Race from Vancouver Island. The Auk, Vol. X, No. 3, July, 1893, p. 240.

This author explains that the measurement of the *bill* was "taken with dividers from pit of nostril to tip of upper mandible."

Ridgway, Robert.

1887. A Manual of North American Birds, September 26, 1887, pp. IX–X.

In this work the following measurements are explained: *total length*, as usual; *length of wing*, with the primaries straightened; *length of tail*, "from tip of longest feathers to their apparent base"; *length of total culmen*, the chord of the curve from its extreme base; chord of *exposed culmen*, from point where feathers close over the base of the culmen to the tip; *depth* (*height*) *of bill*, "measured with dividers, and is a measurement requiring extreme care"; *length of tarsus*, from the tibio-tarsal joint "on the outer side" to the lowest scute in front, or to the middle of the joint with middle toe; and *length of middle toe*, along the upper surface, from the point at its base where it joins the tarsus, to the base of the claw.

1895. A Manual of North American Birds, Second Edition, pp. XI–XII.

Measurements are explained exactly as in the first edition.

1900. A Manual of North American Birds, Fourth Edition, pp. XI–XII.

The explanation of measurements is exactly the same as in previous editions.

1901. The Birds of North and Middle America. Bulletin of the United States National Museum, No. 50, Part I, October 24, 1901, pp. XV–XVI.

The following measurements are explained: *total length*, from tip of bill to tip of tail; *length of wing*, taken without straightening the primaries; *length of tail*, from point of insertion of middle pair of rectrices to tip of longest feather; *length of exposed culmen*, the chord of the distance from the point where the feathers of the forehead cease to hide the culmen, to its tip; *length of total culmen*, the chord of the culmen to its base where the skin of the forehead ends; *depth* (*height*) *of bill at base*, "measured with dividers from lower edge of mandibular rami to highest portion of the culmen" (in this, the first part of the 'Birds of North and Middle America,' however, Ridgway actually measured the height of bill from the culmen to the lowest posterior angle of the exposed horny portion of the side of the mandible); *width of bill at base*, "measured across the chin between the outside of the *gnathidea* at their base" (i. e., *width of mandible*); *length of tarsus*, "measured from the tibio-tarsal or heel joint on the outer side to the lower end"; *length of middle toe*, "from the lower end of the tarsus to the base of the claw"; *graduation of tail*, the distance from the tip of the outermost rectrix to that of the longest.

Roberts, Austin.

1913. The Grass Warblers of South Africa. Annals of the Transvaal Museum, Vol. III, No. 4, January, 1913, p. 229.

The *length of the closed wing* is taken with the feathers straightened along a ruler; the *length of tail*, from base of middle feathers to tip; the chord of the *total culmen;* the *length of tarsus*, "posteriorly, from the top of the bone to the base of the hind toe"; the *length of middle toe without claw*, on upper surface; the *length of first primary*, from base to tip without straightening; and the *length of second primary*, without straightening, from the base of the first primary to the tip of the second.

Sharpe, Richard Bowdler.

1879. A List of the Birds of Labūan Island and Its Dependencies. Proceedings of the Zoological Society of London, for 1879, Part II, August 1, 1879, p. 327.

Mentions that the *length of the wing* is "measured in a straight line from carpal band [bend] to tip of longest primary."

Stark, Arthur Cowell.

1900. The Birds of South Africa. Vol. I, p. x.

The following measurements are explained: *total length*, taken in the usual manner; chord of *length of closed wing; length of tail*, "from the root of the tail, whence the quills spring, to the tip of the longest feather"; *length of tarsus*, from articulation with tibia to articulation with middle toe (whether in front or behind is not stated); and *length of exposed culmen* (presumably the chord).

Stearns, Winfrid Alden; and Coues, Elliott.

1881. New England Bird Life, Part I, p. 24.

Measurements explained are: *total length*, obtained as usual; *extent of wings*, also as commonly taken; *length of wing*, "the distance from the 'bend of the wing' to the end of the longest primary"; *length of tail*, "from the insertion of the feathers in the coccyx to the end of the longest feather"; *length of bill*, "the straight line from the base to the tip of the culmen"; *length of tarsus*, "the distance from the ankle joint to the base of the middle toe."

1883. New England Bird Life, Second Edition, Part I, p. 24.

Explanation of measurements is just the same as in the first edition.

Stejneger, Leonhard.

1884. Remarks on the Type Specimen of Limicola hartlaubii Verr. Zeitschrift für die Gesammte Ornithologie, Jahrg. I, Heft 2, 1884, pp. 84–85.

The measurements used were taken with dividers, and are described as follows: *length of exposed culmen*, "from the border of the feathering of the forehead to the tip"; *length of tarsus*, "from the tibio-tarsal joint, on the outside, to the joint with the middle toe"; *length of middle toe*, from the latter point to the tip of the claw; *length of wing*, "from the bend to the tip of the first [sic] primary without flattening the wing"; and *length of tail*, from the insertion of the middle pair of rectrices to the tips of the same pair.

1885. Results of Ornithological Explorations in the Commander Islands and in Kamtschatka. Bulletin of the United States National Museum, No. 29, December 16, 1885, pp. 7–8.

Measurements explained are *total length*, taken as usual; and *length of tail*, from insertion of the middle pair of feathers to end of longest rectrix.

1887. Contributions to the Natural History of the Commander Islands, No. 7—Revised and Annotated Catalogue of the Birds Inhabiting the Commander Islands. Proceedings of the United States National Museum, Vol. X, July 2, 1887, p. 120.

Mentions two methods of measuring the *tarsus*—"in front," and "from the side."

Swarth, Harry Schelwaldt.

1920. Revision of the Avian Genus Passerella with Special Reference to the Distribution and Migration of the Races in California. University of California Publications in Zoology, Vol. XXI, No. 4, September 11, 1920, pp. 83–84, figs. A and B.

Measurements used in this article are as follows: chord of *length of wing*, with the primaries not straightened; *length of tail*, from the point of insertion of the middle rectrices to the tip of the longest; chord of *exposed culmen; depth (height) of bill*, from the base of exposed culmen to the posterior angle of exposed portion of mandible; *width of "bill"* (i. e., of mandible), at the widest part of the exposed portion of the rami of the mandible; *length of tarsus* (diagonal), from middle of ankle joint

behind to the joint with the middle toe on the anterior side; *length of middle toe with claw*, along upper surface from joint with metatarsus to a point opposite the tip of the claw (thus not the chord, but the horizontal length); and *length of hind toe with claw*, "measured along the under side, from the joint between the hind toe and the metatarsus to the tip of the claw" (thus the chord of the hallux and claw; but the illustration shows a measurement beginning at the basal portion of one of the anterior toes instead of the hallux).

Taverner, Percy A.

1919. Birds of Eastern Canada. Memoir 104, Biological Series, No. 3, Geological Survey, Canada, Department of Mines, p. 3.

The only measurement mentioned is *total length*, taken in the usual manner.

1926. Birds of Western Canada. Museum Bulletin No. 41, Biological Series, No. 10, Victoria Memorial Museum, Canada, Department of Mines, October 12, 1926, p. 3.

No mention is made of any measurement other than *total length*, taken as usual.

van Rossem, Adriaan Joseph.

1926. The California Forms of Agelaius phoeniceus Linnaeus. The Condor, Vol. XXVIII, No. 5, September 21, 1926, p. 218.

The only measurement explained is the *depth (height) of bill at base*, which is "the distance from the posterior lower corner of mandible to the highest point of the culmen."

Wait, William Ernest.

1925. Manual of the Birds of Ceylon, p. 8.

Measurements explained are: *total length*, taken as usual; *length of tail*, from root on under side to tip of longest feather; *length of wing*, with primaries straightened; *length of tarsus*, "from the center of the joint between the tarsus and the tibia to the base of the middle toe"; and *length of bill from gape*.

Wetmore, [Frank] Alexander.

1921. Three New Birds of the Family Tinamidae from South America. Journal of the Washington Academy of Sciences, Vol. XI, No. 18, November 4, 1921, p. 436.

Measurement of the *length of tail* "is taken from coccyx to tip of longest filaments of the mixed rectrices and tail coverts."

1926. Observations on the Birds of Argentina, Paraguay, Uruguay, and Chile. Bulletin of the United States National Museum, No. 133, February 1, 1926, pp. 22, 397.

The measurements explained are: *length of closed wing*, taken without straightening the primaries, i. e., the chord; *length of tail*, from the base of the middle rectrices to the tip of the longest; *total length of culmen*, the chord from the extreme base to the tip; *length of culmen from cere*, the chord from the cere to the tip; *length of tarsus*, from "the upper end of the tarsus on its posterior side" to "the end of the middle trochlea of the metatarsus"; and *height of bill*, "from posterior end of gonys to highest point on culmen."

Witherby, Harry Forbes (edited by); et al.

1919. A Practical Handbook of British Birds, Vol. I, Part I, March 3, 1919, pp. XIII–XIV, 6 figs.

Measurements described and illustrated are: *length of wing*, with primaries straightened; *length of tail*, from insertion of middle pair of feathers to tip of longest; chord of *exposed culmen*; chord of *total culmen;* chord of *culmen without cere;* and *length of tarsus*, from middle of joint with tibia behind to longest scute in front. For large birds the wing is measured with a tape around the curve of the primaries.

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CONTRIBUTIONS FROM THE BALDWIN BIRD RESEARCH LABORATORY

For convenience in reference and library use there are listed below the published papers from the Baldwin Bird Research Laboratory produced by S. Prentiss Baldwin, his assistants, and collaborators.

CONTRIBUTION No. 1.—BALDWIN, S. PRENTISS. **Bird-banding by Means of Systematic Trapping.** Abstract of the Proceedings of the Linnaean Society of New York, No. 31, for 1918–1919 (December 23, 1919) pp. 23–56, pls. I–VII. This paper describes the methods and results of the systematic trapping and banding of birds at Cleveland, Ohio, and Thomasville, Georgia.

CONTRIBUTION No. 2.—BALDWIN, S. PRENTISS. **Recent Returns from Trapping and Banding Birds.** The Auk, Vol. XXXVIII, No. 2, April, 1921, pp. 228–237. A report of bird banding at Thomasville, Georgia, and Cleveland, Ohio, during 1919 and 1920.

CONTRIBUTION No. 3.—BALDWIN, S. PRENTISS. **The Marriage Relations of the House Wren.** The Auk, Vol. XXXVIII, No. 2, April, 1921, pp. 237–244. Mating habits and genealogy, as learned from banded birds, are here discussed.

CONTRIBUTION No. 4.—BALDWIN, S. PRENTISS. **Adventures in Bird Banding in 1921.** The Auk, Vol. XXXIX, No. 2, April, 1922, pp. 210–224, pls. VIII–IX. Bird banding results in 1921 at Thomasville, Georgia, and Cleveland, Ohio, are here given.

CONTRIBUTION No. 5.—TALBOT, LESTER R. **Bird Banding at Thomasville, Georgia, in 1922.** The Auk, Vol. XXXIX, No. 3, July, 1922, pp. 334–350, pls. XV–XVII. Report of Mr. Talbot, who operated the Thomasville bird banding station for Mr. Baldwin in February and March, 1922.

CONTRIBUTION No. 6.—MUSSELMAN, THOMAS E. **Bird Banding at Thomasville, Ga., 1923.** The Auk, Vol. XL, No. 3, July, 1923, pp. 442–452, pls. XXV–XXVII. Report of Mr. Musselman, who operated the Thomasville bird banding station with Mr. Baldwin in February and March, 1923.

CONTRIBUTION No. 7.—MAY, JOHN B. **Bird Banding at Thomasville, Georgia, 1924.** The Auk, Vol. XLI, No. 3, July, 1924, pp. 451–462, pls. XXVII–XXVIII. Report of Doctor May, who operated the Thomasville bird banding station with Mr. Baldwin from January to April, 1924.

CONTRIBUTION No. 8.—BALDWIN, S. PRENTISS. **Bird Banding; Are Birds Frightened or Injured?** The Wilson Bulletin, Vol. XXXVI, No. 2, June, 1924, pp. 101–104.

CONTRIBUTION No. 9.—BALDWIN, S. PRENTISS. **History of the Quail Investigation.** The Wilson Bulletin, Vol. XXXVII, No. 2, June, 1925, pp. 98–100.

CONTRIBUTION No. 10.—BALDWIN, S. PRENTISS; AND KENDEIGH, S. CHARLES. **Attentiveness and Inattentiveness in the Nesting Behavior of the House Wren.** The Auk, Vol. XLIV, No. 2, April, 1927, pp. 206–216, pls. X–XIII. Explains the use of potentiometer and thermocouple in keeping record of nest temperature and movements of female house wren during incubation.

CONTRIBUTION No. 11.—BOULTON, RUDYERD. **Ptilosis of the House Wren.** The Auk, Vol. XLIV, No. 3, July, 1927, pp. 387–414, figs. 1–12. Prepared while Mr. Boulton was acting as assistant at the Baldwin Bird Research Laboratory during the summer of 1926.

CONTRIBUTION No. 12.—MUSSELMAN, THOMAS E. **Foot Disease of Chipping Sparrow (Spizella passerina).** The Auk, Vol. XLV, No. 2, April, 1928, pp. 137–147, pl. VII. A study of bird pox, especially as it appears at Thomasville, Georgia.

CONTRIBUTION No. 13.—BALDWIN, S. PRENTISS; and BOWEN, W. WEDGWOOD. **Nesting and Local Distribution of the House Wren.** The Auk, Vol. XLV, No. 2, April, 1928, pp. 186–199, figs. 1–5. This paper describes the plan and purposes of the 'outfield' work on the house wren at the Baldwin Bird Reseach Laboratory in 1927.

CONTRIBUTION No. 14.—KENDEIGH, S. CHARLES; AND BALDWIN, S. PRENTISS. **Development of Temperature Control in Nestling House Wrens.** American Naturalist, Vol. LXII, No. 680, May–June, 1928, pp. 249–278. A study of body temperature and methods of taking body temperature of birds.

CONTRIBUTION No. 15.—LINCOLN, FREDERICK C. **Bibliography of Bird Banding in America.** The Auk, Vol. XLV, No. 4, Supplement, October, 1928, pp. 1–73. Although this paper was not prepared by a member of the staff of the Baldwin Bird Research Laboratory, it was written at the request of Mr. Baldwin, by Mr. Lincoln, of the United States Biological Survey, by permission of the Biological Survey.

CONTRIBUTION No. 16.—BALDWIN, S. PRENTISS. **A Bird Research Laboratory.** Bulletin of the Northeastern Bird Banding Association, Vol. IV, No. 4, October, 1928, pp. 115–120. A description of the organization and purposes of the Baldwin Bird Research Laboratory.

CONTRIBUTION No. 17.—BALDWIN, S. PRENTISS; OBERHOLSER, HARRY C.; AND WORLEY, LEONARD G. **Measurements of Birds.** Scientific Publications of the Cleveland Museum of Natural History, Vol. II, 1931, pp. I–IX; 1–165; figs. 1–151. A manual of external measurements of birds, for use in biological, systematic, and other studies of variation in the size of birds.

CONTRIBUTION No. 18.—KENDEIGH, S. CHARLES; AND BALDWIN, S. PRENTISS. **The Mechanical Recording of the Nesting Activities of Birds.** The Auk, Vol. XLVII, No. 4, October, 1930, pp. 471–480; pls. XV–XVIII; figs. 1–4. A description of the construction and operation of instruments in use at the Baldwin Bird Research Laboratory.

CONTRIBUTION No. 19.—BALDWIN, S. PRENTISS, **Bird Banding by Systematic Trapping.** Scientific Publications of the Cleveland Museum of Natural History, Vol. I, No. 5, April 15, 1931, pp. 125–168; pls. XIX–XXV. A reprint, with corrections, of contributions from the Baldwin Bird Research Laboratory, No. 1, 'Bird Banding by Means of Systematic Trapping' and No. 3, 'The Marriage Relations of the House Wren.'

CONTRIBUTION No. 20.—BALDWIN, S. PRENTISS. **"Bird Sanctuary" Suggestions.** Ohio Journal of Science, Vol. XXXI, No. 3, May, 1931, pp. 172–176. Suggestions for the establishment and maintenance of sanctuaries for birds, in parks, estates, cemeteries, and golf grounds.

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